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THE

JOHNS HOPKINS

UNIVERSITY CIRCULARS

BALTIMORE

December 1879—September 1882

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EXPLANATORY NOTE.

Since the opening of the Johns Hopkins University in 1876, it has been found convenient to issue frequent statements in respect to the development of its plans. The earliest of these Official Circulars were printed in octavo. Nearly two years ago the form was changed to a quarto, and some of the features of the University Reporter of Cambridge, England, were introduced, particularly current announcements of lectures and courses of instruction. These bulletins were originally designed for the information of those who were connected with this University, or who wished to enter it; but they soon proved to be a convenient channel for acquainting the public at large with the condition of the foundation, and for spreading information in respect to scientific and literary investigations which were here in progress. Gradually the reports of society meetings, and the synopses of scientific papers claimed more and more space, and a demand for the successive circulars was indicated far beyond the company for which the original publication had been designed; and even to a limited extent in foreign countries.

It is now thought best to modify in some particulars the plan of the circulars, so as to give still more space to the original work of the professors in the University and their more advanced students, without omitting the current information in respect to the plans of instruction, the rolls of attendance, and other purely local matters.

In order that a ready reference may be made to the articles of more permanent value which have already been printed, the accompanying index has been constructed by the skillful hand of one of the officers of the University, to whose assiduity and accuracy these pages bear abundant witness. I regret that his reluctance to be named precludes a more definite acknowledgment of his efficient services.

D. C. GILMAN.

Office of the President, Johns Hopkins University,
Baltimore, September, 1882.

JOHNS HOPKINS, a merchant of Baltimore, who died in 1873 in the seventy-ninth year of his age, bequeathed a large part of his fortune to two institutions which perpetuate his name—the Johns Hopkins Hospital, and the Johns Hopkins University. Each foundation received an endowment of not far from three and a half million dollars. The Hospital is now building. The University has just concluded its sixth year of work. The two institutions are separate corporations, but are closely affiliated.

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CHRONOLOGICAL STATEMENT.

1867, August 24.	Incorporation of the Johns Hopkins University.
1870, June 13.	Organization of the Board of Trustees.
1873, December 24.	Death of the Founder; Born May 19, 1794.
1874, February 6.	First Business Meeting of Trustees.
1874, December 30.	Election of a President of the University.
1876, February 22.	Public Announcement of Plans.
1876, September 13.	Opening of the University.
1876, October 3.	Instructions Began.

By the action of the Trustees, May 7, 1877, it was determined that instructions should begin annually on the last Tuesday of September; that the organization of classes should commence one week earlier, and that instructions should close on the second Friday in June.

OFFICERS AND STUDENTS, 1879--80.

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John W. Garrett,
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Charles J. M. Gwinn,
83 Mt. Vernon Place.

Lewis N. Hopkins,
138 St. Paul St.

William Hopkins,
21 Franklin St.

Reverdy Johnson,
Mt. Vernon Hotel.

Francis T. King,
76 Cathedral St.

C. Morton Stewart,
167 Dolphin St.

James Carey Thomas,
317 Madison Ave.

Francis White.
237 St. Paul St.

PRESIDENT OF THE UNIVERSITY.

Gilman, Daniel C. 81 Saratoga Street.
A. B., Yale College, 1852, and A. M., 1855; LL.D., Harvard University and St. John's College, 1876; Professor in Yale College, 1863-72; President University of California, 1872-75.

PROFESSORS.

Gildersleeve, Basil L. 253 St. Paul St. *Greek.*
A. B., Princeton College, 1849, and A. M., 1852; Ph. D., University of Göttingen, 1853; LL. D., College of William and Mary, 1869; Professor of Greek in the University of Virginia, 1856-76; Professor of Latin in the University of Virginia, 1861-66.

Martin, H. Newell 233 St. Paul St. *Biology.*
M. B., University of London, 1871, and Dr. Sc., 1872; A. B., University of Cambridge, 1874, and A. M., 1877; Fellow, and late Lecturer on Natural History in Christ College, Cambridge; Fellow of University College, London.

Morris, Charles D. (Collegiate) 158 N. Howard St. *Latin and Greek.*
A. B., Lincoln College, Oxford, 1849, A. M., and Fellow of Oriel College, Oxford, 1852; Professor in the University of New York, 1875-76.

Remsen, Ira 213 St. Paul St. *Chemistry.*
College of the City of New York; M. D., College of Physicians and Surgeons, N. Y., 1867; Ph. D., University of Gottingen, 1870; Professor of Chemistry in Williams College, 1872-76, and previously Assistant in Chemistry in the University of Tübingen.

Rowland, Henry A. 14 Cathedral St. *Physics.*
C. E., Rensselaer Polytechnic Institute, Troy, 1870; Assistant Professor in the same, 1872-75.

Sylvester, J. J. 139 St. Paul St. *Mathematics.*
A. M., University of Cambridge; F. R. S., London and Edinburgh; Corresponding Member Institute of France; Member, Academy of Sciences in Berlin, Göttingen, Naples, Milan, St Petersburg, etc.; LL. D., University of Dublin, University of Edinburgh; late Professor of Mathematics in the Royal Military Academy, Woolwich.

LECTURERS FOR THE CURRENT YEAR.

Professor J. Willard Gibbs, of Yale College, *Theoretical Dynamics.*

Mr. Sidney Lanier, of Baltimore, *English Literature.*
435 N. Calvert St.

Professor G. S. Morris, University of Michigan, *History of Philosophy.*

Mr. Charles S. Peirce, of the U. S. Coast Survey, *Logic.*
187 N. Howard St.

Professor Leonce Rabillon, of Baltimore, *French Literature.*
69 Park Ave.

FESSOR John Trowbridge, of Harvard University, *Physics.*

ASSOCIATES.

Adams, Herbert B. 123 W. Madison St. *History.*
A. B., Amherst College, 1872, and A. M., 1875; Ph.D., University of Heidelberg, 1876; Lecturer on History at Smith College.

Brandt, Hermann C. G. 228 N. Eutaw St. *German.*
A. B., Hamilton College, 1872, and A. M., 1875; Assistant Professor of Modern Languages in Hamilton College, 1874-76.

Brooks, William K. Lake Roland, Balt. Co. *Biology.*
A. B., Williams College, 1870; Ph. D., Harvard University, 1875.

Browne, William Hand 2 Huntingdon Ave. *Librarian.*
M. D., University of Maryland, 1850.

Cook, Albert S. 123 W. Madison St. *English.*
S. B., Rutgers College, 1872, and S. M., 1875.

Cross, John M. St. Paul & Chase Sts. *New Testament Greek.*
A. B., Princeton College, 1867, and A. M., 1870; Tutor of Greek in Princeton College, 1873-76.

Elliott, A. Marshall 214 N. Howard St. *Romance Languages.*
A. B., Haverford College, 1866, and A. M., 1876; A. B., Harvard University, 1868.

Hastings, Charles S. 8 Denmead St. *Physics.*
Ph. B., Yale College, 1870, and Ph. D., 1873; Holder of the "Tyndall Scholarship," in Paris, 1875.

Lanman, Charles R. 132 W. Madison St. *Sanskrit*
A. B., Yale College, 1871, and Ph. D., 1873.

Morse, Harmon N. 12 Denmead St. *Chemistry.*
A. B., Amherst College, 1873; Ph. D., University of Göttingen, 1875; Instructor in Chemistry at Amherst College, 1875-76.

Scott, Austin Washington, D. C. *History.*
A. B., Yale College, 1869; A. M., University of Michigan, 1870; Ph. D., University of Leipsic, 1873; late Instructor in History at the University of Michigan.

Story, William E. 41 Franklin St. *Mathematics.*
A. B., Harvard University, 1871; Ph. D., University of Leipsic, 1875; Tutor of Mathematics in Harvard University, 1875-76.

Uhler, Philip R. 218 W. Hoffman St. *Natural History.*
Librarian of the Peabody Institute, and President of the Maryland Academy of Sciences.

Warren, Minton 123 W. Madison St. *Latin.*
A. B., Tufts College, 1870; Ph. D., University of Strasburg, 1879.

ASSISTANTS.

Clarke, Samuel F. 267 N. Eutaw St. *Biological Laboratory.*
Ph. B., Yale College, 1878; Ph. D., Johns Hopkins University, 1879.

Craig, Thomas United States Coast Survey. *Mathematics.*
C. E., Lafayette College, 1875; Ph. D., Johns Hopkins University, 1878.

Franklin, Fabian 228 W. Lanvale St. *Mathematics.*
Ph. B., Columbian University, 1869.

Hall, Lyman B. 255 N. Eutaw St. *Chemical Laboratory.*
A. B., Amherst College, 1873; Ph. D., University of Gottingen, 1875.

Sihler, Christian 100 N. Paca St. *Biological Laboratory.*
Concordia College, 1866; M. D., University of Michigan, 1871.

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Former Holders of Fellowships.

Adams, Henry C., (Lecturer at Cornell University) *Political Science.*
A. B., Iowa College, 1874, and A. M., 1877; Ph. D., Johns Hopkins University, 1878.

Bloomfield, Maurice (Student in Vienna, Austria) *Philology.*
A. M., Furman University, (S. C.), 1877; Ph. D., Johns Hopkins University, 1879.

Jacques, William W. 139 Carrollton Ave. *Physics.*
S. B., Massachusetts Institute of Technology, 1876; Ph. D., Johns Hopkins University, 1879.

Sewall, Henry (Student in Leipsic) *Biology.*
S. B., Wesleyan University, 1876; Ph. D., Johns Hopkins University, 1879.

Fellow of Columbia College, N. Y.

Fletcher, Lawrence B. 73 Courtland St. *Physics.*
A. B., Columbia College, 1877.

Miss Christine Ladd, a graduate of Vassar College, whose mathematical attainments had been commended by the Faculty as worthy of the holder of a Fellowship in Mathematics, was invited by the Trustees, June 2, 1879, to continue her studies here for a year, and the usual stipend of a Fellowship was voted to her.

FELLOWS.

Allinson, Francis G. A. B., Haverford College, 1876; A. B., Harvard University, 1877.	123 W. Madison St.	*Greek.*
Ayres, Brown Washington and Lee University; S. B., Stevens Institute of Technology, 1878.	117 Bolton St.	*Physics.*
Bevier, Louis A. B., Rutgers College, 1878.	140 Cathedral St.	*Greek.*
Burney, William S. B., Davidson College, 1875; Ph. D., University of Heidelberg, 1879.	150 W. Biddle St.	*Chemistry.*
Fahlberg, Constantine Ph. D, University of Leipsic, 1873.	35 Courtland St.	*Chemistry.*
Hall, Edwin H. A. B., Bowdoin College, 1875.	270 W. Fayette St.	*Physics.*
Hartwell, Edward M. A. B., Amherst College, 1873, and A. M., 1876.	132 W. Madison St.	*Biology.*
Irby, J. R. McD. S. B., University of Virginia, 1875; Ph. D., University of Göttingen, 1878.	244 N. Howard St.	*Mineralogy.*
Kuhara, Mitsuru S. B., University of Tokio, Japan, 1877.	267 N. Eutaw St.	*Chemistry.*
Marquand, Allan A. B., Princeton College, 1874.	St. James Hotel,	*Logic and Ethics.*
Mitchell, Oscar H. A. B., Marietta College, 1875, and A. M., 1878.	140 Cathedral St.	*Mathematics.*
Nichols, Edward L. S. B., Cornell University, 1875; Ph. D., University of Göttingen, 1879.	67 St Paul St.	*Physics.*
Nicolassen, George F. A. B., University of Virginia, 1879.	622 W. Lombard St.	*Greek.*
Pratt, Waldo S. A. B., Williams College, 1878.	132 W. Madison St.	*Philosophy.*
Prentiss, Robert W. S. B., Rutgers College, 1878.	306 E. Chase St.	*Mathematics.*
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Stringham, Washington I. A. B, Harvard University, 1877.	107 N. Charles St.	*Mathematics.*
Van Velzer, Charles A. S. B., Cornell University, 1876.	122 Myrtle Ave.	*Mathematics.*
Wilson, Edmund B. Ph. B., Yale College, 1878.	267 N. Eutaw St.	*Biology.*
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STUDENTS.

Adkins, William H. Easton (Md.) Classical School.	117 N. Charles St.	*Candidate.*
Alexander, William J. A. B., University of London, 1876.	46 McCulloh St.	*Greek and German.*
Anderson, Newton M. Ohio State University; Massachusetts Institute of Technology.	267 N. Eutaw St.	*Physics and Chemistry.*
Arnold, Jacob D. A. B., Georgetown College, 1873, and A. M., 1876; M. D., Washington University, Balt., 1876.	7 S. High St.	*Biology.*
Arthur, William H. M. D., University of Maryland, 1877.	77 Franklin St.	*Biology.*
Artz, C. Walter Mr. J. T. Carlile, Instructor.	94 Saratoga St.	*Candidate.*
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Bright, James W. A. B., Lafayette College, 1877.	16 McCulloh St.	*Teutonic and Sanskrit.*
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Gilman, Benjamin I. Williams College.	70 Cathedral St.	*Philosop*

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Hussey, George F. Haverford College.	142 Lanvale St.	*Logic.*
Ingle, Edward Baltimore City College.	358 Linden Ave.	*Matriculate.*
James, Walter B. A. B., Yale College, 1879.	261 N. Charles St.	*Biology and Chemistry.*
Jamieson, Alexander F. Phillips Academy, Exeter, 1875.	187 N. Howard St.	*Matriculate.*
Jarvis, Edmund A. Mr. G. G. Carey's School.	31 W. Eager St.	*Matriculate.*
Jenkins, Felix S. Loyola College.	2 Cathedral St.	*Candidate.*
Johnson, John McDonogh School.	266 Myrtle Ave.	*Candidate.*
Keeler, James E. High School, La Salle, Ill.	255 N. Eutaw St.	*Physics.*
Keyser, Newberry A. S. Mr. E. M. Lamb's School.	375 Madison Ave.	*Preliminary Medical.*
Kimball, Richard F. Mr. C. P. Grady's School.	87 Park Ave.	*Candidate.*
Koyl, C. Herschel A. B., Victoria University, Ontario, 1877.	100 N. Paca St.	*Physics.*
Leftwich, Thomas J. Bingham School.	229½ N. Eutaw St.	*Candidate.*
Leonard, Benjamin F. M. D., University of Maryland, 1876.	26 S. Broadway.	*Biology.*
Lewis, John S. M. D., College of Physicians and Surgeons, Baltimore, 1879.	Bay View Asylum.	*Biology.*
Liebig, Gustav A. Dr. Edward Deichmann, Instructor.	307 St. Paul St.	*Matriculate.*
Linthicum, Stewart B. Mr. G. G. Carey's School, 1877.	131 W. Lanvale St.	*Matriculate.*
Lowe, John H. Baltimore City College.	387 Madison Ave.	*Matriculate.*
Mager, Wilhelm Fresenius's Laboratory, Wiesbaden.	44 Pennsylvania Ave.	*Chemistry.*
Mahon, Ormsby L. Baltimore City College.	138 N. Exeter St.	*Candidate*
Mahon, Robert W. C. E., Lehigh University, 1876.	138 N. Exeter St.	*Physics and Chemistry.*
Marston, William S. A. B., Harvard University, 1874.	161 St. Paul St.	*Mathematics.*
McDowell, Whitford L. *Baltimore City College*, 1879.	694 Saratoga St.	*Greek.*
McIlwaine, Clement R. A. B., Hampden Sidney College, 1878.	30 Denmead St.	*History and Philosophy.*
Mitsukuri, Kakichi Ph. B., Yale College, 1879.	267 N. Eutaw St.	*Biology.*
Moale, William A. M. D., University of Maryland, 1879.	152 N. Charles St.	*Biology.*
Moore, William S. A. B., Davidson College, 1877.	150 N. Eutaw St.	*Math. and Physics.*
Morgan, Leigh C. Baltimore City College, 1875.	77 Mulberry St.	*Matriculate.*
Murray, Daniel M. Mr. S. Z. Ammen, Instructor.	59 Cathedral St.	*Candidate.*
Nichols, Charles W. Yale College.	132 W. Madison St.	*Philosophy.*
Norwood, Chalmers C. A. B., Davidson College, 1878.	150 N. Eutaw St.	*Mathematics.*
Ould, Remus Massachusetts Agricultural College.	203 W. Biddle St.	*Chemistry.*
Page, James Baltimore City College.	77 W. John St.	*Matriculate.*
Palmer, A. Chase A. B., Johns Hopkins University, 1879.	96 Townsend St.	*Chemistry.*
Palmer, Albert G. Mr. E. M. Lamb's School.	172 McCulloh St.	*Candidate.*
Palmer, Nelson Mr. G. G. Carey's School, 1877.	96 Townsend St.	*Matriculate.*
Pettigrew, Thomas Hillsboro, N. C., Military Academy.	33 Denmead St.	*Matriculate.*
Prescott, Philip M. Chandler Scientific Department, Dartmouth College.	132 W. Madison St.	*Matriculate.*
Price, Herbert L. Baltimore City College.	48 Mt. Vernon Place.	*Preliminary Medical.*
Pund, Frederick Mr. C. P. Grady's School.	232 N. Gay St.	*Candidate.*
Reese, Robert M. Mr. E. M. Lamb's School.	209 W. Pratt St.	*Candidate.*
Reid, Henry F. C. E., Pennsylvania Military Academy, 1876.	75 Mt. Vernon Place.	*Matriculate.*
Robinson, Adoniram J. Baltimore City College, 1879.	192 Mulberry St.	*Special.*
Roe, Charles S. Oberlin College.	237 W. Biddle St.	*Candidate.*
Rolando, Henry Baltimore City College.	Clifton, Balt. Co.	*Matriculate.*
Sale, Lee Louisville High School, 1878.	196 W. Lombard St.	*Matriculate.*
Sanderson, William R. Lawrenceville (N. J.) High School.	Arlington, Balt. Co.	*Chemistry and Biology.*
Spieker, Edward H. A. B., Johns Hopkins University, 1879.	123 N. Paca St.	*Greek.*
Stevens, Lewis T. Baltimore City College.	105 Charles St. Ave.	*Matriculate.*
Stokes, Henry N. S. B., Haverford College, 1878.	212 W. Hoffman St.	*Chemistry.*
Stricklen, W. Raymond Baltimore City College, 1876.	149 E. Madison St.	*Matriculate.*
Swift, Morrison I. A. B., Williams College, 1879.	123 W. Madison St.	*Greek.*
Thomas, Henry M. Haverford College.	317 Madison Ave.	*Preliminary Medical.*
Thomas, William J. Randolph Macon College.	10 S. Calhoun St.	*Matriculate.*

TIDBALL, WILLIAM J. A. B., Davidson College, 1878.	150 N. Eutaw St.	*Greek.*
TIFFANY, HERBERT T. Mr. S. E. Turner, Instructor.	85 Bolton St.	*Matriculate.*
TORRISON, ISAAC B. A. B., Norwegian Luther College, Iowa, 1879.	282 E. Pratt St.	*Greek.*
TRIMBLE, ISAAC R. Shenandoah Valley Academy.	187 Maryland Ave.	*Preliminary Medical.*
WARFIELD, MACTIER Ury House School.	112 St. Paul St.	*Preliminary Medical.*
WARREN, HENRY C. A. B., Harvard University, 1879.	132 W. Madison St.	*Sanskrit and Teutonic.*
WHITMAN, FRANK P. A. B., Brown University, 1874.	267 N. Eutaw St.	*Chemistry and Physics.*
WHITNEY, MILTON, JR. Prof. M. A. Newell, Instructor.	421 N. Calvert St.	*Chemistry.*
WILHELM, LEWIS W. Baltimore City College, 1871.	64 Pennsylvania Ave.	*Matriculate.*
WILLIAMS, N. WINSLOW Baltimore City College.	60 Franklin St.	*History and Languages.*
WILSON, HENRY M., JR. Mr. G. G. Carey's School.	251 Madison Ave.	*Candidate.*
WOOD, P. BRYSON St. John's College.	187 N. Howard St.	*Preliminary Medical.*
WOODS, HIRAM, JR. A. B., Princeton College, 1879.	374 Eutaw Place.	*Biology and Physics.*

SUMMARY.

President and Professors,	7
Lecturers,	6
Associates,	14
Assistants,	5

ENROLLED STUDENTS.

Graduate Students (including 20 Fellows),*	71
Matriculated Students,	30
Students not Matriculated,	44
WHOLE NUMBER OF ENROLLED SCHOLARS,	**145**

HOLDERS OF GRADUATE SCHOLARSHIPS GIVEN BY THE PROFESSORS.

1879.	A. CHASE PALMER, (A. B., Johns Hopkins),	Baltimore.
	EDWARD H. SPIEKER, (A. B., Johns Hopkins),	Baltimore.

HOLDERS OF UNIVERSITY SCHOLARSHIPS.

1878.	W. W. BADEN, (Steuart Hall),	Baltimore.
	J. W. BROWN, (Mr. G. G. Carey's School),	Govanstown.
1879.	EDWARD INGLE, (Balt. City College),	Baltimore.
	L. T. STEVENS, (Balt. City College),	Baltimore.
	H. T. TIFFANY, (Mr. S. E. Turner, Instructor),	Baltimore.

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* Two of whom are absent for this year.

Classification by States of Enrolled Students, 1879-80.

Maryland, (Baltimore 69),	86
Other States, 59 viz:	
New York,	10
New Jersey,	5
Massachusetts,	4
North Carolina,	4
Ohio,	4
Virginia,	3
Connecticut,	3
Illinois,	3
Iowa,	3
Pennsylvania,	2
Kentucky,	2
District of Columbia,	2
Ontario (Canada),	2
Japan,	2
Maine,	1
Vermont,	1
Georgia,	1
Florida,	1
Louisiana,	1
Michigan,	1
Wisconsin,	1
Missouri,	1
Kansas,	1
Russia,	1

List of Institutions at which the Graduate Students (1879-80) received their Bachelor's Degree:

Harvard University,	5
Yale College,	4
Davidson College,	4
Virginia, University of,	3
Cornell University,	3
Williams College,	3
Norwegian Luther College (Iowa),	3
Princeton College,	2
Rutgers College,	2
Michigan, University of,	2
Haverford College,	2
Johns Hopkins University,	2
Amherst College,	1
Bowdoin College,	1
Brown University,	1
Central College (Mo.),	1
Centre College (Ky.)	1
Columbia College,	1
Dartmouth College,	1
Furman University (S. C.),	1
Georgetown College (D. C.),	1
Hamilton College,	1
Hampden-Sidney College,	1
Iowa College,	1
London, University of,	1
Lehigh University,	1
Lafayette College,	1
Mass. Inst. of Technology,	1
Marietta College,	1
Northwestern University (Wis.)	1
Rochester University,	1
St. John's College,	1
Stevens Inst. of Technology,	1
Tokio (Japan), University of,	1
Victoria University (Ont.),	1
Wesleyan University,	1
Washington and Lee University,	1

List of Institutions at which the Graduate Students (1879-80) have received the Degree of Master or Doctor.

Maryland, University of,	14
Johns Hopkins University,	4
Göttingen, University of,	2
Leipsic University of,	1
Heidelberg, University of,	1
Virginia, University of,	1
Rochester, University of,	1
Michigan, University of,	1
Amherst College,	1
Iowa College,	1
Georgetown College (D. C.),	1
Marietta College,	1
Washington and Lee University,	1
Washington University (Balt.),	1
Physicians and Surgeons, College of, (Balt.),	1

Summary of Students Enrolled during the last three Academic Years.

	Graduates, including Fellows.	Matriculates.	Non-Matriculates.	Total.
1876-77,	54	12	23	89
1877-78,	58	24	22	104
1878-79,	63	25	35	123
*1879-80,	71	30	44	145

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*At the opening of the fourth year.

DURING the academic year 1878-79 the following special classes were instructed, in addition to those above enumerated:

Persons attending a Course in Hydrodynamics,	8
Persons attending a Course on the Theory of the Telescope,	15
Persons attending the Chesapeake Zoölogical Laboratory,	10
Teachers attending a class in Zoölogy,	15
Medical Students attending Demonstrations in Animal Physiology,	25
Medical Students attending a course in Animal Histology,	12

Average attendance upon public lectures 1879-80, (not included in either of above summaries).

General Biology,	66
French Literature,	35
Mediæval History,	83
Greek History,	39
Ethics,	123
Greek Scriptures,	12
Hebrew Scriptures,	41
German Empire,	258
Dante,	152
Thirty Years War,	192
Botany,	89
Political Science,	87
Greek Archæology,	88

HOURS OF LECTURES AND RECITATIONS—SEPTEMBER to DECEMBER, 1879.

Hours.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.	SATURDAY.
A. M. 9	Chemistry (Prof. Remsen). Aristotle (Prof. Morris). Latin Prose (Dr. Warren). Quaternions (Dr. Story). Logic (Mr. Peirce). Sanskrit, Proverbs (Dr. Lanman).	Chemistry (Prof. Remsen). Greek Prose (Prof. Morris). Horace (Dr. Warren). Theory of Equations (Mr. Franklin). Greek Exercise (Prof. Gildersleeve). Hymns of Rig-Veda (Dr. Lanman).	Chemistry (Dr. Morse). Aristotle (Prof. Morris). Horace (Dr. Warren). Quaternions (Dr. Story). Gothic (Mr. Brandt). Crystallography (Dr. Irby). Logic (Mr. Peirce).	Chemistry (Prof. Remsen). Aristotle (Prof. Morris). Horace (Dr. Warren). Theory of Equations (Mr. Franklin). Logic (Mr. Peirce). Sanskrit, Proverbs (Dr. Lanman).	Chemistry (Prof. Remsen). Greek Prose (Prof. Morris). Horace (Dr. Warren). Quaternions (Dr. Story). Greek Exercise (Prof. Gildersleeve). Hymns of Rig-Veda (Dr. Lanman).	Chemistry (Dr. Morse). History (Dr. Adams). Physics, Laboratory Work (Dr. Hastings). Saturday Class 9 A. M.—5 P. M. Elementary Sanskrit (Dr. Lanman).
10	Physics (Dr. Hastings). Homer (Prof. Morris). Advanced Morphology (Dr. Brooks).	Physics (Dr. Hastings). Greek Prose (Prof. Morris). Terence (Dr. Warren). English (Mr. Cook). Elliptic Functions (Dr. Story). Advanced Physiology (Prof. Martin).	Physics (Dr. Hastings). Homer (Prof. Morris). Terence (Dr. Warren). Elliptic Functions (Dr. Story). Advanced Morphology (Dr. Brooks).	Physics (Dr. Hastings). Homer (Prof. Morris). Terence (Dr. Warren). English (Mr. Cook). Elliptic Functions (Dr. Story). Advanced Morphology (Dr. Brooks).	Physics (Dr. Hastings). Homer (Prof. Morris). Terence (Dr. Warren). Anglo Saxon (Mr. Cook). Advanced Physiology (Dr. Martin).	Physics. Lecture to Advanced Students (Dr. Hastings). English (Mr. Cook). Advanced Morphology (Dr. Brooks).
11	Elementary Biology (Prof. Martin). Lessing, Nathan (Mr. Brandt). Calculus (Mr. Franklin).	Osteology (Dr. Brooks). German Prose Composition (Mr. Brandt). New Testament Greek (Mr. Cross). Mathematical Physics (Prof. Rowland). Anglo Saxon (Mr. Cook).	Elementary Biology (Prof. Martin). Schiller, Prose (Mr. Brandt). New Testament Greek (Mr. Cross) Mathematical Physics (Prof. Rowland). Calculus (Mr. Franklin).	Elementary Biology (Prof. Martin). Lectures on German Ballads (Mr. Brandt). Mathematical Physics (Prof. Rowland). Anglo Saxon (Mr. Cook).	Osteology (Dr. Brooks). Schiller, Prose (Mr. Brandt). New Testament Greek (Mr. Cross). Mathematical Physics (Prof. Rowland). Calculus (Mr. Franklin).	Elementary Biology (Prof. Martin). Gothic (Mr. Brandt). Crystallography (Dr. Irby).
M. 12	Greek Lyric Poetry (Prof. Gildersleeve). German Exercise (Mr. Brandt). French: Class B, Minor Course (Mr. Elliott). Higher Plane Curves (Dr. Story) Analytical Chemistry (Dr. Morse)	Pindar (Prof. Gildersleeve). Goethe, Prose (Mr. Brandt). French: Class B, Minor Course (Mr. Elliott). Higher Plane Curves (Dr. Story).	Greek Seminary (Prof. Gildersleeve). Goethe, Prose (Mr. Brandt). French: Class B, Minor Course (Mr. Elliott). Analytical Chemistry (Dr. Morse).	Pindar (Prof. Gildersleeve). Bluntschli, Volkerrecht (Mr. Brandt). French: Class B, Minor Course (Mr. Elliott). Higher Plane Curves (Dr. Story). Analytical Chemistry (Dr. Morse).	Greek Seminary (Prof. Gildersleeve). Bluntschli, Volkerrecht (Mr. Brandt). French: Class B, Minor Course (Mr. Elliott). Higher Plane Curves (Dr. Story). Analytical Chemistry (Dr. Morse)	
P. M. 1	French: Class A, Minor Course (Mr. Elliott). Differential Equations (Dr. Story). Conics (Mr. Franklin).	French: Class A, Minor Course (Mr. Elliott). Theory of Numbers (Prof. Sylvester). French: Major Course (Mr. Elliott).	French: Class A, Minor Course (Mr. Elliott). Differential Equations (Dr. Story) Conics (Mr. Franklin).	French: Class A, Minor Course (Mr. Elliott). Differential Equations (Dr. Story) Conics (Mr Franklin). Villehardouin (Mr. Elliott).	French: Class A, Minor Course (Mr. Elliott). Theory of Numbers (Prof. Sylvester).	
2	Drawing (Mr. Newell).	Physiography (Dr. Clarke). New Testament Exegesis (Mr. Cross, 2.30 P. M).		Physiography (Dr. Clarke).	Drawing (Mr. Newell).	
3		Physiological Demonstrations to Medical Students (Prof. Martin 3.30 P. M). Mediæval Logic (Mr. Peirce).			Romance Languages, Lecture to Advanced Students (Mr. Elliott).	Physiological Demonstrations to Medical Students (Dr. Sihler, 3.30 P. M).
4	History (Dr. Adams). English (Mr. Cook). Plautus (Dr. Warren).	History (Dr. Adams). English (Mr. Cook).	History (Dr. Adams). English (Mr. Cook). Elementary Sanskrit (Dr. Lanman)	History (Dr. Adams). English (Mr. Cook).	History (Dr. Adams). English (Mr. Cook). Provençal (Mr. Elliott).	
5	Public Lecture. Schiller, *Neffe als Onkel* (Mr Brandt).	Public Lecture. Spherical Harmonics (Dr. Craig, 7 P. M).	Schiller, *Neffe als Onkel* (Mr. Brandt).	Public Lecture. Calculus of Variations (Dr. Craig, 7 P. M.)	Public Lecture. Schiller, *Neffe als Onkel* (Mr. Brandt). Calculus of Variations (Dr. Craig, 7 P. M). Old French and Wallachian (Mr. Elliott).	

Death of Herman Voorhees, a Fellow of the Johns Hopkins University.

Born August 18, 1852. Died October 14, 1879.

On Tuesday last, at Ballston, died Herman Voorhees, who, for the last ten years, has been known with great favor in this city, and who, at the time of his death, was about twenty-seven or twenty-eight years of age. He entered the Rensselaer Polytechnic Institute in 1869, and during the four years of his course of study at that school of science, maintained a high standing. He was graduated in 1873 with the degree of civil engineer, and in the fall of 1875 went to Germany and entered the University of Göttingen, and there pursued the study of chemistry under the celebrated scientist, Prof. Wöhler. His intention was to remain there two years, and to obtain the degree of Ph. D., but he was prevented from accomplishing this design by the death of his father, and returned home in the fall of 1876. Becoming then a member of the Faculty of the Rensselaer Polytechnic Institute, he was chosen as assistant to the chairs of geodesy and descriptive geometry. This position he held for two years, and then in the fall of 1878, entered the Johns Hopkins University at Baltimore, Md., in order to continue his chemical studies under Prof. Ira Remsen, an authority of high repute in the study of organic chemistry. At this university there are fellowships lasting for a year and renewable yearly, to which certain emoluments and privileges are attached. To win one of these fellowships was the desire of Mr. Voorhees, and for this object he strove. While most arduously engaged in his studies, he was attacked last spring with a hemorrhage, the attack occurring as he was one day pursuing his investigations in the laboratory of the University. About this time he also received notice that he had gained the fellowship which he had so ardently sought. But he never lived to enjoy its privileges, or to honor the choice of those who had so esteemed his ability and learning, for although hopes of his recovery were entertained, the improvement upon which these hopes were based proved to be only temporary. He passed the greater part of the last summer among the Adirondacks. Returning to the house of his brother, Theodore Voorhees, in the late summer, he there remained, the subject of the kindest and most considerate attentions, until his death.—*From the Troy Morning Whig, of Thursday morning, October* 16, 1879.

FOURTH ANNUAL REPORT.

The Annual Report of the President of the University is now ready for distribution.

It contains seventy-six pages, including the appendix. It gives a review of the last three years, by which the public may judge not only of the plans adopted, but also of their operation during this preliminary period. Among the topics discussed are university and collegiate work, fellowships, graduate students, undergraduate students, library and apparatus, relations to other institutions, investigations and publications, examinations and degrees, public lectures, teachers' class in zoölogy, instruction preliminary to medical studies. The appendix has several noteworthy tabular statements, *e. g.*:

Roll of Fellows, with a brief statement of their academic work.
Enumeration of Classes.
Lists of Scientific Apparatus.
Lists of Scientific Papers published by members of the University.

BRIEF ANNOUNCEMENTS.

Professor John Trowbridge, of Harvard University, will deliver a course of twelve public lectures on the Philosophy of Physics, beginning January 20, 1880.

The aim of this course will be to present the subjects of Mechanics, Heat, Sound, Light, Electricity and Magnetism in a logical way; breaking down the barriers by which they are fenced about in popular estimation. Consideration will be given to the methods of thought which scientific men adopt, and they will be contrasted with those followed in other intellectual fields.

The lecturer will endeavor to give to the subject of Physics an interesting and humanitarian aspect, and to call attention to the importance of the study.

Professor J. Willard Gibbs, of Yale College, will lecture on Theoretical Dynamics, four or five times weekly, during January and February 1880, beginning on Monday, January 5.

The principle of virtual velocities will be taken as the point of departure, and the subject will be treated somewhat on the plan of the *Mécanique Analytique;* but other methods of developing the subject will be noticed and critically compared with that of Lagrange. The notations, generally known as quaternionic, in which direction and magnitude are expressed by a single letter, will be used to a considerable extent, but not so as to presuppose any knowledge of Quaternions, as all notions and notations borrowed from that science will be fully explained, and their essential properties demonstrated.

The object of this course will be to develop the general principles of Mechanics in their mutual connections, and to explain its most important methods.

Reading. The reading of the *Mécanique Analytique* is strongly recommended. For the purposes of preliminary study by less advanced students, Sturm's *Cours de Mécanique* or Todhunter's *Analytical Statics*, with Tait and Steele's *Dynamics of a Particle*, may be recommended; but many other treatises, as those of Delaunay, Duhamel, Laurent, Resal, etc., would perhaps be equally suitable.

☞A knowledge of the elements of the Calculus of Variations is indispensable to all pursuing this course.

Mr Charles S Peirce, of the U. S. Coast and Geodetic Survey, has begun his lectures on Logic to special students of that subject. He may be seen at his study, 187 North Howard Street.

S. F. Clarke (Ph. D, Johns Hopkins) has been engaged to give a course of instruction in Physical Geography to the students who have entered upon the course preliminary to medicine. A small appropriation for maps has been made by the Trustees.

Dr. Thomas Craig, of the U. S. Coast and Geodetic Survey, has begun courses of lectures on the Calculus of Variations, and on Spherical Harmonics.

Mr. Hugh Newell, Instructor of Drawing in the Maryland Institute, has been invited to give instruction at the Johns Hopkins University, and particularly to students who are beginning a course of study in the Biological Sciences

Mr. C. L Woodworth (A. M., Amherst) is giving a course of instruction in the management and cultivation of the voice, to individual members of this University who apply to him.

J. R. McD. Irby (Ph. D., Göttingen), Fellow in Mineralogy, has formed a class for the study of Crystallography.

Mr. A. V. E Young, of the University of Michigan, has resigned his Fellowship in Chemistry, in order to have more time for private pursuits.

The next number of these Circulars will contain a statement showing in detail all the lectures and classes now in progress or announced for the current year in mathematics and physics; library bulletins stating the principal accessions of books and new periodicals since September 1, 1879, by the University and other Baltimore libraries; and a full schedule of the courses of public lectures now in progress in Baltimore.

American Journal of Mathematics

PURE AND APPLIED.

Editor in Chief, J. J. Sylvester, Professor of Mathematics; Associate Editor in Charge, William E. Story, Associate in Mathematics; with the co-operation of Simon Newcomb, H. A. Newton and H. A. Rowland.

Issued under the auspices of the Johns Hopkins University.

Published in the quarto form and in numbers appearing four times a year. Subscription Price per Volume, of about 384 pages, $5 00; price per number $1.50. Vol. I. 1878-79 (388 pp., 4 plates) can still be furnished at the subscription price. All communications should be addressed to the Associate Editor in charge.

CONTENTS FOR DECEMBER, 1879, Vol. II. No. 3.

1. On the Geographical Problem of the Four Colours, by A. B. Kempe, London, England.
2. Note on the Preceding Paper by William E. Story.
3. The Quaternion Formulae for Quantification of Curves, Surfaces and Solids, and for Barycentres, by W. I. Stringham, Fellow of Johns Hopkins University.
4. On the Dynamics of a "Curved Ball," by Ormond Stone, Cincinnati, O.
5. Note on Determinants and Duadic Synthemes, by J. J. Sylvester.
6. Tables of the Generating Functions and Groundforms for the Binary Quantics of the First Ten Orders, by J. J. Sylvester, assisted by F. Franklin, of the Johns Hopkins University.
7. Note on the Projection of the General Locus of Space of Four Dimensions into Space of Three Dimensions, by Thomas Craig, Fellow of Johns Hopkins University.
8. On the Motion of an Ellipsoid in a Fluid, by Thomas Craig, Fellow of Johns Hopkins University.
9. A New Proof of the Theorem of Reciprocity, by Dr. Julius Petersen, Copenhagen, Denmark.
10. On a New Action of the Magnet on Electric Currents, by E. H. Hall, Fellow of Johns Hopkins University.
11. On Ternary Cubic-Form Equations. Chapter I. On the Resolution of Numbers into Sums and Differences of Two Cubes, by J. J. Sylvester.

AMERICAN CHEMICAL JOURNAL.

Edited, with the aid of Chemists at Home and Abroad,

By IRA REMSEN, Professor of Chemistry in the Johns Hopkins University.

Contains original articles by American and foreign chemists; reviews of works relating to chemical science; reports on progress in the various departments of Chemistry; and items of general interest to Chemists.

Published in numbers of from 64 to 80 pages; six numbers forming a volume of from 400 to 500 pages.

Price for the volume $3.00; single numbers 50 cents.

Subscriptions and communications should be addressed to the Editor.

CONTENTS for OCTOBER 1879, Vol. I. No. IV.

Researches on the Complex Inorganic Acids, by Wolcott Gibbs.

Contributions from the Sheffield Laboratory of Yale College, viz:

- On Some Compounds of Aromatic Amines with Silver Nitrate and Sulphate, by W. G. Mixter.
- On Clarke's Method for the Separation of Tin from Arsenic and Antimony, by Fred. P. Dewey.
- Influence of Acetic Acid on the Separation of Iron as a Basic Acetate from Manganese, Zinc, Cobalt and Nickel, by John Jewett.

On the Action of Iodine Monochloride upon Aromatic Amines, b A. Michael and Lewis M. Norton.

The Action of Phthalic Anhydride on Napthalene in the Pres ence of Chloride of Aluminium, by Emile Ader and James M Crafts.

Notes on Para-Nitro and Para-Amido Phenetol, by E. J. Halloc

Reviews, Reports and Notes, by J. W. Mallet, the Editor, and other

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AMERICAN JOURNAL OF PHILOLOGY.

Edited, with the co-operation of leading scholars, by B. L. Gildersleeve, Professor of Greek in th Johns Hopkins University.

This Journal will be open to original communications in all departments of Philology, classical, comparative, oriental an modern; yet a large portion of the space will be given up to condensed reports of current philological work, and arrangements hav been made to present regularly summaries of the chief articles in the leading philological journals of Europe, while a close watc will be kept over the fragmentary and occasional literature to which the isolated American scholar seldom has full access. Th reviews of books will be intrusted as far as possible to specialists: and it is hoped that the Journal will meet a want that has lon been acknowledged among American scholars, and serve as a means of inter-communication and as an organ of independent criticism

The Journal will be in the ordinary review form, four numbers to constitute a volume, of from 400 to 500 pages, one volum to appear each year.

The subscription price will be three dollars a year, payable upon the receipt of the first number. Vol. I, No. I is now in press

All communications should be addressed to the Editor.

Copies of the Johns Hopkins University Circulars may be obtained, as soon as published, of Messrs. CUSHINGS & BAILEY, No 262 West Baltimore Street, Baltimore. Price 5 cents each.

EW-YORK

JOHNS HOPKINS UNIVERSITY CIRCULARS.

Published with the approbation of the Board of Trustees.

No. 2.] BALTIMORE, JANUARY, 1880. [PRICE 5 CENTS.

CALENDAR.

January 6-16.	**Lectures on Japanese Art, at the Peabody, by Prof. W. E. Griffis.**
January 7.	**Prof. Gibbs's Course in Rational Mechanics begins.**
January 9-16.	**Dr. Brooks's Course on the Structure, etc, of the Crab and the Oyster.**
January 10.	**Dr. Warren's Course in Historical Latin Grammar begins.**
January 20—February 6.	**Lectures on Ideality in the Physical Sciences, at the Peabody, by Prof. Benjamin Peirce.**
January 20—February 6.	**Prof. Trowbridge's Course on the Philosophy of Physics.**
February 10-19.	**Lectures on Vocal Culture, at the Peabody, by Prof. J. W. Churchill.**
February 10—March 30.	**Dr. Adams's Course on the Italian Renaissance, etc.**
February 11—April 28.	**Prof. Gildersleeve's Readings in the Greek Tragic Poets.**
February 23—May 3.	**Prof. Morris's Course on British Thought and Thinkers.**
February 24-26.	**Lectures on Celestial Chemistry, at the Peabody, by Prof. G. F. Barker.**
March 2-4.	**Lectures on Color Blindness, at the Peabody, by Dr B. J. Jeffries.**

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MEETINGS OF SOCIETIES, Etc.

Scientific. First Wednesday of each month, at 8 P. M. Next meeting, February 4. S. F. Clarke, Sec'y.

Philological. First Friday of each month, at 12 M. Next meeting, February 6. C. R. Lanman, Sec'y.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, January 16. H. B. Adams, Sec'y.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, January 13. Allan Marquand, Sec'y.

Biological. Thursday of each week, at 4 P. M.

Mathematical Seminary. Third Wednesday of each month, at 8 P. M. Next meeting, January 21.

Greek Seminary. Wednesday of each week, at 12 M.

PUBLIC LECTURES.

Lectures will be in progress, during January, in Hopkins Hall at 5 P. M. :

Dr. Brooks, on the *Structure, Habits and Development of the Crab and the Oyster*, Friday, January 9, Monday, January 12, and Friday, January 16.

Prof. Trowbridge, on the *Philosophy of Physics*, Tuesday, Wednesday, Thursday, and Friday of each week, January 20—February 6.

ENUMERATION OF CLASSES, FIRST HALF-YEAR, 1879-80.

Mathematics. (31 Students.)

Theory of Numbers: Prof. Sylvester. Twice weekly, Tuesday and Friday, 1 P. M. (8).

Franklin.
Hathaway.
Ladd.
Marston.
Mitchell.
Prentiss.
Stringham.
Van Velzer.

Mathematical Seminary: Prof. Sylvester and Dr. Story. Third Wednesday of each month, 8 P. M. (15).

Bissing.
Bland.
Coleman.
Franklin.
Freeman.
Hathaway.
Ladd.
Marston.
Mitchell.
Moore.
Norwood.
Prentiss.
Stringham.
Thomas, W. J.
Van Velzer.

Quaternions: Dr. Story. Thrice weekly, Monday, Wednesday and Friday, 9 A. M. (4).

Mitchell.
Moore.
Prentiss.
Van Velzer.

Elliptic Functions: Second Course: Dr. Story. Thrice weekly, Tuesday, Wednesday and Thursday, 10 A. M. (4).

Ladd.
Prentiss.
Stringham.
Van Volzer.

Differential Equations: Dr. Story. Thrice weekly, Monday, Wednesday and Thursday, 1 P. M. (8).

Bissing.
Brown.
Gantt.
Mitchell.
Norwood.
Prentiss.
Reid.
Wilhelm.

Higher Plane Curves: Dr. Story. Four times weekly, Monday, Tuesday, Thursday and Friday, 12 M. (5).

Brown.
Gantt.
Norwood.
Stringham.
Wilhelm.

Calculus of Variations: Dr. Craig. Twice weekly, Thursday and Friday, 7 P. M. (9).

Ayres.
Bissing.
Fletcher.
Hall, E. H.
Koyl.
Mitchell.
Nichols, E. L.
Prentiss.
Stringham.

Spherical Harmonics: Dr. Craig. Once weekly, Tuesday, 7 P. M. (6).

Ayres
Fletcher.
Koyl.
Mitchell.
Prentiss.
Stringham.

Differential Calculus: Mr. Franklin. Thrice weekly, Monday, Wednesday and Friday, 11 A. M. (9).

Anderson.
Bissing.
Coleman.
Day, W. C.
Keeler.
Koyl.
Liebig.
Page.
Whitman.

Conic Sections: Mr. Franklin, with manuscript notes by Dr. Story. Thrice weekly, Monday, Wednesday and Thursday, 1 P. M. (5).

Anderson.
Coleman.
Day, W. C.
Page.
Whitman.

Theory of Equations: Mr. Franklin. Twice weekly, Tuesday and Thursday, 9 A. M. (6).

Brown.
Fahlberg.
Gantt.
Moore.
Norwood.
Reid.

Physics. (33 Students.)

General Physics: Dr. Hastings. Daily, 10 A. M. (15).

Berry.
Harlan
Jamieson.
Jenkins.
Liebig.
Lowe.
Moore.
Morgan.
Palmer, A. C.
Reid.
Stevens.
Thomas, H. M.
Tiffany.
Warfield.
Woods.

Laboratory Work: Professor Rowland. Daily, 9 A. M. 5 P. M. (10 advanced students).

Anderson.
Ayres.
Fletcher.
Freeman.
Hall, E. H.
Jacques.
Koyl.
Mahon, R. W.
Nichols, E. L.
Whitman.

Theory of Heat Conduction: Prof. Rowland. Four tin weekly, Tuesday, Wednesday, Thursday and Friday, 11 A. M. (

Ayres.
Brown.
Fletcher.
Gantt.
Hall, E. H.

Electricity and Magnetism: Prof. Rowland. Twe lectures and five recitations. (Course now completed.) (3).

Ayres.
Fletcher.
Hall, E. H.

Major Course: Dr. Hastings. Lectures on Theory of Obser tions, and selected problems in Physics. Once weekly, Saturday, A. M. (9).

Brown.
Cone.
Day, W. C.
Freeman.
Gantt.
Keeler.
Prentiss.
Stringham.
Whitman.

Saturday Class (*A*). Dr. Hastings. Laboratory Work, 10 A. to 1 P. M. (8).

Harlan.
Howell.
Liebig.
Reid.
Stevens.
Thomas, H. M.
Warfield.
Woods.

Saturday Class (*B*). Laboratory Work from 11 A. M. thro the day. (9).

(Composed of same members as "Major Course" Class above.)

Chemistry. (44 Students).

General Chemistry: Four lectures by Prof. Remsen, and examinations by Dr. Morse, weekly, (including Saturday), 9 A. (21).

Anderson.
Bissing.
Bruere.
Coleman.
Dosh.
Freeman.
Grammer.
Hall, E. H.
Howell.
James, W. B.
Keyser.
Mahon, R. W.
Palmer, A. G.
Price.
Sanderson.
Stevens.
Thomas, H. M.
Trimble.
Whitman.
Whitney.
Wood.

Laboratory Work: Prof. Remsen, Dr. Morse and Dr. L Hall. Daily. (31).

Anderson.
Bond, A. K.
Broun.
Burney.
Coale.
Coleman.
Day, D. T.
Day, W. C.
Fahlberg.
Hall, E. H.
Hartwell.
Howell.
James, W. B.
Kuhara.
Linthicum.
Mager.
Mahon, R. W.
Ould.
Palmer, A. C.
Palmer, N.
Pennington.
Pund.
Rolando.
Sedgwick.
Sihler.
Stokes.
Warfield.
Whitman.
Whitney.
Wood.
Young.

Analytical Chemistry: Dr. Morse. Four times weekly, M day, Tuesday, Thursday and Friday, 12 M. (15).

Bond, A. K.
Coleman.
Fletcher.
Hall, E. H.
Howell.
Kuhara.
Linthicum.
Mahon, R. W.
Ould.
Pund.
Rolando.
Sihler.
Stokes.
Warfield.
Wood.

Biology. (27 Students.)

Animal Physiology: Prof. Martin. Twice weekly, Tuesday and Friday, 10 A. M. (9).

Arnold.
Bond, A. K.
Hartwell.
Jarvis.
Marquand.
Mitsukuri.
Pratt.
Sedgwick.
Wilson, E. B.

General Biology: Prof. Martin. Four times weekly, Monday, Wednesday, Thursday and Saturday, 11 A. M. (11).

Donaldson.
Dosh.
Howell.
James, W. B.
Keyser.
Mitsukuri.
Moale.
Rolando.
Sedgwick.
Wilson, E. B.
Woods.

Animal Morphology: Dr. Brooks. Four times weekly, Monday, Wednesday, Thursday and Saturday, 10 A. M. (4).

Hartwell.
Mitsukuri.
Sedgwick.
Wilson, E. B.

Osteology: Human and Comparative: Dr. Brooks. Twice weekly, Tuesday and Friday, 11 A. M. (9).

Dosh.
Howell.
James, W. B.
Keyser.
Mitsukuri.
Rolando.
Wilson, E. B.
Wood.
Woods.

Histology: Special Course in Laboratory. Dr. Sihler. (4).

Lewis.
Mitsukuri.
Sedgwick.
Wilson, E. B.

Special Students, engaged in original investigation in the Laboratory:

Atkinson.
Booker.
Councilman.

Preliminary: (Not including Graduates). (7).

Bruere.
Keyser.
Price.
Thomas, H. M.
Trimble.
Warfield.
Wood.

Greek. (33 Students.)

Pindar: Prof. Gildersleeve. Twice weekly, Tuesday and Thursday, 12 M. (7).

Allinson.
Bevier.
Bristol.
Glenn.
Nicolassen.
Spieker.
Tidball.

Greek Lyric Poetry: Prof. Gildersleeve. Once weekly, Monday, 12 M. (8).

Allinson.
Bevier.
Bristol.
Glenn.
Nicolassen.
Spieker.
Swift.
Tidball.

Greek Seminary: Prof. Gildersleeve. Twice weekly, Wednesday and Friday, 12 M. (11).

Allinson.
Bevier.
Bothne.
Bristol.
Glenn.
Grammer.
Jamieson.
Nicolassen.
Spieker.
Swift.
Tidball.

Greek Composition and Translation: Prof. Gildersleeve. Twice weekly, Tuesday and Friday, 9 A. M. (13).

Alexander.
Allinson.
Beadenkopf.
Bevier.
Bothne.
Bristol.
Glenn.
Jamieson.
Nicolassen.
Sale.
Spieker.
Swift.
Tidball.

Aristotle: Rhetoric: Prof. C. D. Morris. Thrice weekly, Monday, Wednesday and Thursday, 9 A. M. (12).

Alexander.
Baden.
Beadenkopf.
Bothne.
Gjellum.
Jamieson.
Morgan.
Sale.
Stricklen.
Swift.
Tidball.
Torrison.

Homer: Odyssey: Prof. C. D. Morris. Four times weekly, Monday, Wednesday, Thursday and Friday, 10 A. M. (6).

Adkins.
Artz.
Ebeling.
Grammer.
Ingle.
Wilson, H. M.

New Testament Greek: Mr. Cross. Thrice weekly, Wednesday, Thursday and Friday, 11 A. M. (8).

Allinson.
Cumming.
Gjellum.
Jamieson.
McDowell.
Morgan.
Schorr.
Watson.

New Testament Exegesis: Mr. Cross. Once weekly, Tuesday, 2.30 P. M. (4).

Campbell.
Fox.
Jones.
McIlwaine.

Latin. (38 Students).

Plautus: Dr. Warren. Once weekly, Monday, 4 P. M. (13).

Alexander.
Allinson.
Beadenkopf.
Converse.
Gjellum.
Glenn.
Jamieson.
Nicolassen.
Palmer, N.
Sale.
Spieker.
Swift.
Tidball.

Terence: Dr. Warren. Four times weekly, Tuesday, Wednesday, Thursday and Friday, 10 A. M. (14).

Alexander.
Baden.
Beadenkopf.
Bowdoin.
Cheek.
Gittings.
Goodman.
Kimball.
Linthicum.
Palmer, N.
Pettigrew.
Sale.
Stricklen.
Tidball.

Horace: Dr. Warren. Four times weekly, Tuesday, Wednesday, Thursday and Friday, 9 A. M. (18).

Adkins.
Artz.
Cheek.
Cumming.
Drey.
Ebeling.
Harlan.
Hodges.
Ingle.
Leftwich.
Murray.
Page.
Pettigrew.
Reese.
Robinson.
Schorr.
Tiffany.
Wilson, H. M.

German. (58 Students)

Gothic: *Ulfila:* Mr. Brandt. Twice weekly, Wednesday, 9 A. M., and Saturday, 11 A. M. (2).

Bright.
Warren, H. C.

German Prose Composition: ***Essays:*** Mr. Brandt. Once weekly, Tuesday, 11 A. M. (17).

Cone.
Day, D. T.
Day, W. C.
Ebeling.
Gephart.
Gerke.
Goodman.
Keeler.
Linthicum.
Norwood.
Page.
Palmer, A. C.
Palmer, N.
Pettigrew.
Pund.
Stevens.
Wilhelm.

German Ballads: Mr. Brandt. One Lecture weekly, Thursday, 11 A. M. (17).

Cone.
Day, D. T.
Day, W. C.
Goodman.
Jamieson.
Johnson.
Keeler.
Linthicum.
Morgan.
Norwood.
Page.
Palmer, N.
Pettigrew.
Pund.
Stevens.
Thomas, W. J.
Wilhelm.

Lessing: *Nathan der Weise.* Mr. Brandt. Once weekly, Monday, 11 A. M. (14).

Baden.
Bright.
Cone.
Day, D. T.
Goodman.
Linthicum.
Morgan.
Norwood.
Page.
Pettigrew.
Pund.
Sale.
Stevens.
Thomas, W. J.

Humboldt: *Ansichten der Natur*, and ***Schiller, Prosa.*** Mr. Brandt. Twice weekly, Wednesday and Friday, 11 A. M. (10).

Cone.
Day, D. T.
Gerke.
Jarvis.
Johnson.
Linthicum.
Norwood.
Page.
Stevens.
Swift.

Minor Course, Class B, First Division: Goethe, *Prosa*; Bluntschli, *Völkerrecht.* Four times weekly, Tuesday, Wednesday, Thursday and Friday, 12 M. (18).

Alexander.
Arnold.
Berry.
Bowdoin.
Brinton.
Drey.
Gavin.
Gittings.
Ingle.
Jenkins.
Mauck.
McIlwaine.
Reese.
Reid.
Robinson.
Tiffany.
Williams.
Woods.

Minor Course, Class B, Second Division: Mr. Brandt. Schiller, *Neffe als Onkel*; Exercises; Grammar. Thrice weekly, Monday, Wednesday and Friday, 5 P. M. (12).

Bond, A. K.
Bruere.
Core.
Crisp.
Keyser.
Kuhara.
Mahon, O. L.
Palmer, A. G.
Price.
Thomas, H. M.
Trimble.
Wood.

Minor Course: German Exercises: Mr. Brandt. Once weekly, Monday, 12 M. (17).

Alexander.
Baden.
Berry.
Bowdoin.
Brinton.
Drey.
Gittings.
Howell.
Ingle.
Jarvis.
Jenkins.
McIlwaine.
Reese.
Reid.
Robinson.
Tiffany.
Williams.

English. (14 Students).

Anglo-Saxon. Mr. Cook. Thrice weekly, Tuesday and Thursday, 11 A. M., and Friday, 10 A. M. (1).

Bright.

Shakespeare, Class A. Mr. Cook. Daily, 4 P. M. (7).

Bruere.
Cheek.
Harlan.
Johnson.
Palmer, A. G.
Price.
Reese.

Shakespeare, Class B. Mr. Cook. Twice weekly, Tuesday and Saturday, 10 A. M. (6).

Bothne.
Core.
Gephart.
Keyser.
Torrison.
Wood.

Romance Languages. (37 Students).

Romance Dialects: Mr. Elliott. Lectures, once weekly, Friday, 3 P. M. (3).

Fay.
Garner.
O'Connor.

Provençal: *Girart de Rossilho* and *Marcabrun.* Mr. Elliott. Once weekly, Friday, 4 P. M. (3).

Fay.
Garner.
O'Connor.

Wallachian: *Alecsandri, Collection of Poems.* Mr. Elliott. Once weekly, Friday, 5 P. M. (3).

Fay.
Garner.
O'Connor.

French: Advanced Course: *Alexandre d'Alberic de Besançon.* Mr. Elliott. Once weekly. (3).

Fay.
Garner.
O'Connor.

French: Major Course: Lectures on the Distribution, etc., of the Romance Languages. Mr. Elliott. Once weekly, Tuesday, 1 P. M.: XIII. century French, *Villehardouin*; Bartsch: *Chrestomathie.* Mr. Elliott. Once weekly, Thursday 1 P. M. (7).

Bothne.
Cone.
Nicolassen.
O'Connor.
Pratt.
Reese.
Torrison.

French: Minor Course, Class A. Mr. Elliott. Daily, P. M. (14).

Berry.
Brinton.
Cone.
Drey.
Hodges.
Johnson.
Liebig.
Mahon, O. L.
McIlwaine.
Reese.
Robinson.
Stevens.
Thomas, H. M.
Tiffany.

French: Minor Course, Class B. Mr. Elliott. Daily, 12
(10).

Baden.
Crisp.
Day, D. T.
Day, W. C.
Dosh.
Gephart.
Gerke.
Keeler.
Page.
Trimble.

French: Conversation Class: Prof. Rabillon. Daily. Mon
day, Wednesday and Thursday, 10 A. M., Tuesday and Friday, P. M. (7).

Donaldson.
Gantt.
Goodman.
Jarvis.
Johnson.
Linthicum.
Thomas, W. J.

Sanskrit. (7 Students).

Hymns of the Rig-Veda. Dr. Lanman. Twice weekly, Tue
day and Friday, 9 A. M. (1).

Warren.

Advanced Sanskrit: *Proverbs:* Dr. Lanman. Twice weekl
Monday and Thursday, 9 A. M. (2).

Allinson.
Bevier.

Elementary Sanskrit: Dr. Lanman. Twice weekly, Wedne
day, 4 P. M., and Saturday, 9 A. M. (4).

Bright.
Nicolassen.
Spieker.
Sundberg.

History. (28 Students).

History of the Renaissance and Reformation. Dr. Adam
Daily, 4 P. M. (17).

Adkins.
Bowdoin.
Brinton.
Core.
Crisp.
Ebeling.
Gephart.
Goodman.
Kimball.
Lowe.
Mahon, O. L.
McIlwaine.
Murray.
Robinson.
Thomas, W. J.
Wilhelm.
Williams.

English Constitutional History: Stubbs' *Select Charte*
Dr. Adams Once weekly, Saturday, 9 A. M. (15)

Bowdoin.
Brinton.
Core.
Crisp.
Ebeling.
Gjellum.
Goodman.
Lowe.
Mahon, O. L.
McIlwaine.
Murray.
Robinson.
Thomas, W. J.
Torrison.
Whiteley.

Comparative Constitutional History: Dr. Adams. On
weekly, Saturday evenings. (11).

Annan.
Brantly.
Brinton.
Culbreth.
Goodman.
Hartwell.
James, H. A.
McIlwaine.
Stewart.
Swift.
Whiteley.

Logic. (16 Students).

General Course: Mr. Peirce. Thrice weekly, Monday, We
nesday and Thursday, 9 A. M. (14).

Core.
Cumming.
Gantt.
Gephart.
Gilman, B. I.
Glenn.
Hartwell.
Hussey.
Jarvis.
Ladd.
Marquand.
Newell.
Nichols, C. W.
Pratt.

Mediæval Logic. Mr. Peirce. Once weekly, Friday, 3 P. M. (5

Marquand.
Mitchell.
Newell.
Nichols.
Stringham.

Physiography. (18 Students.)

Dr. Clarke. Twice weekly, Tuesday and Thursday, 2 P. M.

Bruere.
Jarvis.
Keyser.
Palmer, N.
Price.
Pond.
Reid.
Stevens.
Stokes.
Thomas, H. M.
Trimble.
Warfield.
Wood.

Crystallography. (5 Students.)

Dr. Irby. Twice weekly, Wednesday 9 A. M., Saturday 11 A. M.

Bissing.
Day.
Fletcher.
Palmer, A. C.
Pond.

Drawing. (9 Students.)

Mr. Newell. Twice weekly, Monday and Friday, 2 P. M.

Bissing.
Bond. A. K.
Dosh.
Jarvis.
Pettigrew.
Stokes.
Trimble.
Wilhelm.
Woods.

Vocal Training. (30 Students)

Mr. C. L. Woodworth, Jr. Thrice weekly.

Adkins.
Beadenkopf.
Bond, A. K.
Bothne.
Brinton.
Bruere.
Cheek.
Coleman.
Cone.
Crisp.
Cumming.
Dosh.
Ebeling.
Gantt.
Gjellum.
Ingle.
Johnson.
Kimball.
Mahon, O. L.
Morgan.
Page.
Palmer.
Reese.
Stokes.
Thomas.
Torrison.
Trimble.
Warfield.
Wilhelm.
Williams.

LIST OF SOCIETIES

And of Members of the University Connected Therewith.

Scientific Association. Meets in Hopkins Hall, first Wednesday of each month, 8 P. M. Prof. Sylvester, *President;* Prof. Remsen, *Vice-President;* Dr. Clarke, *Secretary.*

Anderson.
Booker.
Brooks.
Burney.
Clarke.
Councilman.
Craig.
Fahlberg.
Fletcher.
Franklin.
Hall, E. H.
Hall, L. B.
Hartwell.
Hastings.
Irby.
Jacques.
Keeler.
Kuhara.
Martin.
Mitchell.
Mitsukuri.
Morse.
Nichols, E. L.
Prentiss.
Remsen.
Rowland.
Sedgwick.
Sihler.
Story.
Stringham.
Sylvester.
Uhler.
Van Velzer.
Whitman.
Wilson, E. B.
Young. (36.)

Philological Association. Meets in Hopkins Hall, first Friday of each month, 12 M. Prof. Gildersleeve, *President;* Dr. Lanman, *Secretary.* (27 members.)

Alexander.
Allinson.
Bevier.
Bothne.
Brandt.
Bright.
Bristol.
Cook.
Cross.
Elliott.
Fay.
Garner.
Gildersleeve.
Gjellum.
Glenn.
Jamieson.
Lanman.
Morris, C. D.
Nicolassen.
Rabillon.
Spieker.
Sundberg.
Swift.
Tidball.
Torrison.
Warren, H. C.
Warren, M. (27.)

History and Political Science Association. Meets in Hopkins Hall, third Friday of each month, 8 P. M. President Gilman, *President;* Dr. Scott, *Vice-President;* Dr. Adams, *Secretary.*

Adams.
Annan.
Bowdoin.
Brantly.
Brinton.
Culbreth.
Gilman, D. C.
Goodman.
Hartwell.
James, H. A.
Lowe.
McIlwaine.
Sale.
Scott.
Sharp.
Stewart.
Thomas, W. J.
Whiteley. (18.)

In addition to those above named, there are attendant upon this Association a number of students of history and political science not connected with the University.

Metaphysical Club. Meets in Room B, 187 N. Howard St., second Tuesday of each month, 8 P. M. Mr. Peirce, *President;* Mr. Marquand, *Secretary.*

Core.
Cumming.
Gantt.
Gephart.
Gilman, B. I.
Glenn.
Hartwell.
Hussey.
Jarvis.
Marquand.
Mitchell.
Newell.
Nichols, C. W.
Peirce.
Pratt.
Stringham. (16.)

Biological Association. Meets in the Biological Laboratory, Wednesday of each week. 4 P. M.

Brooks.
Clarke.
Councilman.
Hartwell.
Martin.
Mitsukuri.
Sedgwick.
Sihler.
Wilson, E. B. (9.)

TEACHERS' CLASS IN EARLY ENGLISH.

A Teachers' Class, strictly limited to twenty persons, will be formed for the study of the English Language in its earliest forms, to be taught by Mr. Albert S. Cook, Associate of the University.

The course of twelve lessons will begin Saturday, Jan. 10, in Hopkins Hall, and continue on successive Saturdays till April 4. The class will meet regularly at 10 A. M., and remain in session two hours. Absence for any cause not deemed sufficient by the instructor, will terminate the absentee's connection with the class.

The plan of instruction will be as follows:

On the basis of a simple Anglo-Saxon text, an investigation will be made into the inflectional forms peculiar to the earliest English; the laws of sound-change, and the reasons for them; the processes of phonetic decay, and the modifications, both of form and meaning, which words have undergone during the transition from Anglo-Saxon to modern English. The endeavor will be to reason from facts to principles, and not conversely; and the subject will be divested, as far as practicable, of all embarrassing technicalities. Opportunity will also be afforded the members of the class to present idioms and constructions of especial difficulty, to be solved, if possible, by a reference to the facts exhibited by the language in its earlier stages.

Applications for admission will now be received by the President of the University, and satisfactory evidence will be required that the applicant is prepared to profit by the course.

None but those who are engaged in teaching, or who are preparing to teach, will be received.

A registration fee of one dollar will be charged to each accepted student, payable at the Treasurer's office.

UNIVERSITY ROOMS AND HOURS.

The rooms marked by numbers are in the University Buildings, corner of Howard and Ross Streets, and those indicated by letters are in No. 187 N. Howard Street, between Ross and Monument Streets.

Consultation Hours.

Saturdays and Sundays are excepted

The President and members of the Academic Staff will receive students and other persons desiring to consult them, at the hours and places indicated in the following schedule.

For the economy of time, on the part both of the Faculty and of the students, it is particularly requested that official consultations be made, except in special emergencies, as appointed below.

PRESIDENT GILMAN is seldom absent from the buildings between 9 A. M. and 2 P. M., and is often in his office during the afternoon. Routine business and matters of minor importance may be brought to his attention orally, between 9 and 10 A. M., or at other times by notes and memoranda left with the clerk in the Registrar's office.

ADAMS, H. B., Associate in History, *Room* 3, 5 *P. M.*
BRANDT, H. C. G., Associate in German, *Room D*, 187 *N. Howard St.*, 10-11 *A. M.*
BROOKS, W. K., Associate in Biology, *Biological Laboratory*, 9 10 *A. M.*
BROWNE, W. H., Librarian, *Library*, 9 *A. M*-5 *P. M.*
COOK, A. S., Associate in English, *Room B*, 187 *N. Howard St.*, 5 *P. M.*
CLARKE, S. F., Assistant in Biology, *Biological Laboratory*, 9 *A. M.*
CROSS, J. M., Associate in New Testament Greek, *Room G*, 187 *N. Howard St.*, 10-11 *A. M.*
ELLIOTT, A. M., Associate in Modern Philology, *Room C*, 187 *N. Howard St.*, 1 *P. M.*
FRANKLIN, F., Assistant in Mathematics, *Room* 16, 2 *P. M.*
GILDERSLEEVE, B. L., Professor of Greek, *Room* 14, 11 *A. M.*-12 *M.*
HASTINGS, C. S., Associate in Physics, *Room* 7, 11 *A. M.*-12 *M.*
LANMAN, C. R., Associate in Sanskrit, *Room C*, 187 *N. Howard St.*, 9 *A. M.*
MARTIN, H. N., Professor of Biology, *Biological Laboratory*, 2-3 *P. M.*
MORRIS, C. D., Professor of Greek, *Room* 4, 11 *A. M.*
MORSE, H. N., Associate in Chemistry, *Chemical Laboratory*, 11 *A. M.*-12 *M.*
NEWELL, H., Instructor in Drawing, *Room* 16, *Monday and Friday*, 3 *P. M.*
PEIRCE, C. S., Lecturer on Logic, *Room F*, 187 *N. Howard St.*, (on overcast days) 10 *A. M.*-12 M.
RABILLON, L., Lecturer on French Literature, *Annex to Hopkins Hall, Monday, Wednesday and Thursday*, 10 *A. M.*, *Tuesday and Friday*, 2 *P. M.*
REMSEN, IRA, Professor of Chemistry, *Chemical Laboratory*, 11 *A. M.*-12 *M.*
ROWLAND, H. A., Professor of Physics, *Physical Laboratory*, 9-10 *A M.*
SIHLER, CHRISTIAN, Assistant in Biology, *Biological Laboratory*, 9-10 *A. M.*
STORY, W. E., Associate in Mathematics, *as posted at Room* 15.
SYLVESTER, J. J., Professor of Mathematics, *Room* 17, *as posted at Room* 15.
WARREN, MINTON, Associate in Latin, *Room* 3, (except Monday), 11 *A. M.*
WOODWORTH, C. L., Instructor in Vocal Culture, *No.* 205 *N. Howard St.*, 4-5 *P. M.*

Treasurer's Office.

MR. C. J. MEYER will be in attendance in the Treasurer's Office, in the University Buildings, 9-11 A. M., 3-5 P. M.

Receipt and Departure of Mails, Etc.

(Including Saturdays).

Mails are received from the Post-office at 9 A. M. and 4 P. M.
Mails are sent to the Post-office at 8 A. M. and 3 P. M.
Mails are sent to the Street Letter-Box at 12 M. and 6 P. M.

☞ Memoranda, notes, letters and parcels may be left at the Registrar's office to be distributed at 9 A. M. and 4 P. M.

Library and Laboratories.

The Library is open daily, including Saturdays, from 9 A. M. to 10 P. M.

The Biological Laboratory is open daily from 9 A. M. to 5 P. M., except Wednesdays and Saturdays, when it closes at 2 P. M.

The Chemical Laboratory is open daily, excepting Saturdays, from 9 A. M. to 5 P. M.

The Physical Laboratory is open daily, including Saturdays, from 9 A. M. to 5 P. M

PEABODY INSTITUTE LIBRARY, (corner of Mt. Vernon and Washington Places), contains 67,000 volumes, and is open daily, from 9 A. M. to 9 P. M.

MERCANTILE LIBRARY, (corner St. Paul and Saratoga Sts.), contains 35,000 volumes.

The Library and Reading Rooms are open daily, to members, from 9 A. M. to 10 P. M. Subscription, five dollars per annum.

MARYLAND HISTORICAL SOCIETY LIBRARY, (corner St. Paul and Saratoga Sts.), contains over 13,000 volumes, and is open from 10 A. M. to 2 P. M.

MARYLAND INSTITUTE LIBRARY, (Baltimore Street, opposite Harrison St.), contains 17,000 volumes, and is open from 9 A. M. to 9 P. M. Member's ticket three dollars per annum.

BAR LIBRARY, (second story, Court House, corner Lexington and Calvert Sts.), contains 7800 volumes, and is open daily, from 9 A. M. to 11 P. M.

MEDICAL AND CHIRURGICAL FACULTY LIBRARY, (122 W. Fayette St.), contains 2000 volumes, and is open daily, from 9 A. M. to 6 P. M.

MARYLAND ACADEMY OF SCIENCES: MUSEUM, (32½ Mulberry St., opposite Cathedral St.), is open daily, from 9 A. M. to 3 P. M.

ADDITIONS TO ROLL OF STUDENTS.

December 1, 1879 to January 1, 1880.

(The full list of students will be found in University Circulars, No. I. pp. 3-5).

MAUCK, J. W. A. B., Hillsdale College, 1875.	263 N. Howard St.	*Greek.*
O'CONNOR, BERNARD F. *Bach. ès Lettres, Université de France.*	81 Franklin St.	*Romance Languages.*
SCHORR, HENRY G. Dickinson College.	57 Eastern Ave.	*Special.*
WATSON, EDWARD L. Baltimore City College, 1879.	363 E. Monument St.	*New Testament Greek.*

HOPKINS HALL LECTURES AND READINGS AT 5 P. M.

The following courses of lectures and readings, to be given in Hopkins Hall at 5 P. M., will be open to the public, subject to the regulations as to tickets, etc., heretofore announced.

I. **Biology,** by DR. BROOKS. Three lectures on the Structure, Habits and Development of the Crab and the Oyster, Friday, January 9; Monday, January 12; Friday, January 16.

II. **Physics,** by Professor JOHN TROWBRIDGE, of Harvard University. Twelve lectures on The Philosophy of Physics.

SPECIAL TOPICS AND DATES.

1. Physical Science Defined, Tuesday, January 20.
2. Force, Wednesday, January 21.
3. Work, Thursday, January 22.
4. Work and Heat, Friday, January 23.
5. Cycles of Transformation, Tuesday, January 27.
6. Molecular Theories, Wednesday, January 28.
7. Perpetual Motion, Thursday, January 29.
8. Sound, Friday, January 30.
9. Light, Tuesday, February 3.
10. Electricity, Wednesday, February 4.
11. Magnetism, Thursday, February 5.
12. The Directions of Physical Science, Friday, February 6.

The aim of this course will be to present the subjects of Mechanics, Heat, Sound, Light, Electricity and Magnetism in a logical way; breaking down the barriers by which they are fenced about in popular estimation. Consideration will be given to the methods of thought which scientific men adopt, and they will be contrasted with those followed in other intellectual fields.

The lecturer will endeavor to give to the subject of Physics an interesting and humanitarian aspect, and to call attention to the importance of the study.

III. **History***, by DR. ADAMS. Ten lectures on the Italian Renaissance and the Beginnings of Modern History, Tuesdays, February 10–March 30.

IV. **Greek***, by Professor GILDERSLEEVE. Twelve Readings in the Greek Tragic Poets, Wednesdays, February 11–April 28.

V. **History of Philosophy,** by Prof. G. S. MORRIS, of the University of Michigan. Eleven lectures, on British Thought and Thinkers.

SPECIAL TOPICS AND DATES.

1. The General Characteristics of the English Mind, Monday, February 23.
2. Mediæval Anticipations of Modern English Thought, (John Scotus Erigena, John of Salisbury, Roger Bacon, John Duns Scotus, William of Occam), Monday, March 1.
3. Englishmen of the Renaissance, (Edmund Spenser, Sir John Davies, Richard Hooker), Monday, March 8.
4. William Shakspere, Monday, March 15.
5. Francis Bacon, Monday, March 22.
6. Thomas Hobbes, Monday, March 29.
7. John Locke, Monday, April 5.
8. George Berkeley, Monday, April 12.
9. David Hume, Monday, April 19.
10. Sir William Hamilton, Monday, April 26.
11. John Stuart Mill, Monday, May 3.

Of these lectures the last seven will be largely biographical, though in each case the attempt will be made to state pointedly the special purport of the speculative thought of the writer under discussion.

VI. **History,*** by DR. SCOTT. Ten lectures, on The Methods of Historical Inquiry, beginning Tuesday, April 6.

* Special topics and dates of these courses will be hereafter announced.

PEABODY HALL LECTURES AT 8 P. M.

The following courses of lectures have been announced by the Trustees of the Peabody Institute, to be delivered during the months of January–March, 1880.

I. **Japanese Art,** by Prof. WM. ELLIOTT GRIFFIS, formerly of the University of Tokio. Four illustrated lectures.

History and Symbolism, Tuesday, January 6.
Technical Processes, Thursday, January 8.
The Ceramic Art, Tuesday, January 13.
Bronze, Ivory, and Crystal, Thursday, January 15.

II. **Ideality in the Physical Sciences, and especially in Astronomy,** by Prof. BENJAMIN PEIRCE, of Harvard University. Six lectures.

Ideality in Science, Tuesday, January 20.
Cosmogony, Thursday, January 22.
Nebular Theory, Tuesday, January 27.
The Sidereal Universe, Thursday, January 29.
Planets, Comets and Meteors, Tuesday, February 3.
Potentiality, Thursday, February 5.

III. **Vocal Culture, with Readings,** by Prof. J. W. CHURCHILL, of the Andover Theological Seminary. Four lectures.

The Voice as an Instrument, Tuesday, February 10.
The Physiological Laws of Speech, Thursday, February 12.
Vocal Culture, Tuesday, February 17.
The Aesthetic View of Speech, Thursday, February 19.

IV. **Celestial Chemistry,** by Prof. GEORGE F. BARKER, of the University of Pennsylvania. Two illustrated lectures.

Spectrum Analysis, Tuesday, February 24.
Chemistry of the Sun, Thursday, February 26.

V. **Color Blindness,** by B. JOY JEFFRIES, M. D. Two lectures.

The Color Sense and its Imperfection or Absence, Tuesday, March 2.
Color-Blindness: its Frequency and its Detection, Thursday, March 4.

MEETINGS OF UNIVERSITY SOCIETIES.

Scientific Association.

October 7, 1879. Twenty-seven persons present.

(1) A statement of the object and history of the Association was given in a brief address by the President, PROFESSOR SYLVESTER.

(2) PROFESSOR REMSEN gave an account of results obtained by the Meyer Bros., from investigations upon the nature of chlorine; showing that at high temperatures its specific gravity changes.

(3) A brief general account of the work of the Chesapeake Zoölogical Laboratory in 1879, was given by Dr. CLARKE.

The facilities for work were much superior to those of the first season. A steam-launch from the Navy Department, and a well-equipped steam-yacht, provided by Maj. Ferguson, were at the disposal of the party. Among the most important results obtained may be mentioned:

(1) The embryological history of a number of brachyuran crustacea representing various genera, worked out by Prof. E. A. Birge.

(2) A careful study of Actinotrocha and its wonderful change into the adult Phoronis form, made by Mr. E. B. Wilson.

(3) The development of the ctenophore Mnemiopsis, by Professor Nunn, who succeeded in getting valuable results regarding the changes which accompany the fertilization of the egg.

(4) Some very interesting points in regard to the earliest changes which occur in the fertilized eggs of Hippa, by Dr. Emil Bessels.

(5) Professor Brooks secured a very complete series in the development of a squid (Loligo), one of the most interesting results from the study of which is the discovery of a rudimentary velum in this group of molluscs.

(6) The most valuable work of the season was done by Professor Brooks, on the development of the American oyster. Some of the most important points reached are:

a. The oyster is unisexual.

b. Segmentation is very rapid, and results, (in two to twenty-four hours,) in a free-swimming gastrula-form with a velum.

c. The blastopore closes; the endoderm and ectoderm separate, and the two valves of the shell are formed separate, at the edge of the closed blastopore.

d. The mouth is formed by invagination at a point opposite the closed blastopore, and the anus is formed close by.

e. The shell grows rapidly, the embryo sinks, becomes attached and soon acquires the adult form.

The segmentation of the oyster is very peculiar, and throws considerable light on the origin and relationship of the Lamellibranchs to various other molluscan groups. The scientific report is now under way, and promises to be a very satisfactory and valuable one.

November 5, 1879. Eighteen persons present.

(1) DR. STORY presented, with comments, a communication by Mr. A. B. KEMPE, of London, On the Geographical Problem of the Four Colors.

A resumé of Mr. Kempe's proof that every map on a singly-connected surface can be colored with four colors, with an extension of the proof to certain cases not considered by the author. (See Am. Journ. of Math. II. 3.)

Remarks were made upon this paper by Mr. C. S. PEIRCE.

(2) DR. BROOKS read a paper On the Method of Inductive Reasoning by Selected Evidence in Morphological Problems.

The destruction, by natural selection, of those transitional forms of animal life which should connect the great groups, has brought into use a peculiar method of logical reasoning, by which a general law, drawn from phenomena which are manifested by a single representative of a group, is applied to the whole group. The paper was an attempt to indicate the limitations and scope of this form of reasoning.

(3) DR. NICHOLS read a paper On the Nature of the Absorption of Gases by Liquids.

This phenomenon is a special case of fluid diffusion. Whenever a liquid and gas are in contact, such diffusion occurs.

The rate of diffusion depends upon the nature of the liquid and gas, the pressure and temperature. Absorption and evaporation are strictly analogous. In each case the point of saturation is reached when an equal number of molecules leave and enter the liquid in a unit of time.

In some cases something akin to chemical union seems to occur. It differs from the union between H and O in H_2O, C and O in CO_2, &c., in that, when the saturated solution is heated or its pressure reduced, gas molecules are given off instead of the more complex molecules supposed to exist in the solution. An extension of this discussion to solutions and mixtures in general, *is in preparation, and* will be presented at a future meeting.

December 3, 1879. Twenty-five persons present.

(1) Remarks were offered by the Vice-President, PROFESSOR REMSEN in the Chair, expressing the great loss which the scientific world has sustained in the recent death of Prof. James Clerk Maxwell, Professor of Experimental Physics in the University of Cambridge, England.

From a letter of W. Spottiswoode, Esq., President of the Royal Society, London, to Prof. Sylvester:

"The death of Clerk Maxwell has made a sad gap in the ranks of science. He died after a short illness of a few weeks, from some internal inflammation to which it proved impossible to get access. He retained his faculties to the last, and was quite conscious of his approaching end. He had begun, and finished half of the first volume of a new edition of his Electricity. He had lately finished the volume of Cavendish's papers, which he had lately edited, but he was also pouring forth a great quantity of new matter which I fear no one can take up. Lord Rayleigh has, in reply to a very strongly-supported request, undertaken the professorship."

The members of this University may be interested in knowing that for several years Professor Maxwell has been interested in the work of Professor Rowland and of Professor J. Willard Gibbs, with the former of whom he frequently corresponded.

Lord Rayleigh, who has been chosen as the successor of Professor Maxwell, was recently President of the London Mathematical Society. Professor De Morgan was the first President of this Society, and Professor Sylvester the second.

(2) The regular communications of the evening were opened with a paper by MR. E. H. HALL, on a New Action of the Magnet on Electric Currents.

Mr. Hall's experiments show that when a strong magnetic current passes in the same direction as a neighboring electric current, it causes the latter to change its course. It is well known that magnets may act mechanically upon *conductors* bearing electric currents. But the fact that a magnet can act upon the *electric current* itself, and permanently modify the conditions of flow, even in a fixed conductor, is now for the first time made known. (This paper is printed in the American Journal of Mathematics for December 1879.)

(3) PROFESSOR ROWLAND offered two explanations of this phenomenon:

(1) That it is an action somewhat analogous to the magnetic rotation of the plane of polarization of light, *i. e.* the effect on the electric current is to cause it to rotate around the line of magnetic force.

(2) That it is a case similar to magneto-electric induction, the electric current being analogous to the moving conductor in the case of ordinary induction.

At the close of the meeting the Association adjourned to the Physical Laboratory, where a physical demonstration of this discovery was given by Mr. Hall.

(4) MR. C. S. PEIRCE discussed a new point in respect to the Geographical Problem of the Four Colors, showing by methods of logical argumentation that a better demonstration of the problem than the one offered by Mr. Kempe is possible. (See meeting of Nov. 5, 1879.)

(5) PROFESSOR REMSEN made a communication upon some experiments of Seelheim.

In the course of these, it was found that platinum at high temperatures in the presence of chlorine is volatilized. Attention was called to the point that this fact will vitiate the results obtained by the Meyer Brothers in their experiments upon the nature of chlorine gas, in which they had discovered that chlorine at high temperatures changes its specific gravity.

(6) DR. IRBY gave a description of peculiar twin crystals of calcite (artificially produced), exhibiting specimens.

These crystals are produced by a process recently described by L. Baumhaer, of Lüdinghausen. The experiment was also tried in the presence of the Society, a portion of one crystal being transferred by pressure from the original to the twin position.

Historical and Political Science Association.

October 23, 1879. Forty-eight persons present.

(1) Address from PRESIDENT GILMAN on the Educational Progress of the United States from 1869 to 1879, since printed in the American Journal of Social Science, No. 9, Boston, 1879.

(2) Communication by DR. W. H. BROWNE, Librarian of the University, on an Old Maryland Land Grant, (dated 1673,) which was

exhibited, and served to illustrate the proprietary system of land tenure as practised in this State, (or then Palatinate), under the Lords Baltimore.

(3) Remarks by DR. H. B. ADAMS, on the Origin of the *Monumenta Germaniae Historica* and the *Rerum Britannicarum Medii Aevi Scriptores.* He also explained the nature and extent of the historical collections to be found in the Peabody Library.

November 21, 1879. Thirty-five persons present.

(1) The principal paper was by MR. W. T. BRANTLY, on the Influence of European Speculation in the Formation of the Constitution of the United States.

He showed that the constitutional doctrines of American statesmen in the last century were due to English rather than to French influence; that John Locke, and not Jean-Jacques Rousseau, was the fountain-head of the theory of the Social Contract; that from the former were borrowed not merely ideas of government, but, to some extent, the phraseology of the Declaration of Independence; and that also to English Public Law, our Constitution is considerably indebted. The influence of Montesquieu, who drew his political wisdom from English sources, was considered at some length, and it was shown that from his *Esprit des Lois* our early American statesmen obtained most of their historical illustrations. It was claimed that the strict separation between the executive, legislative, and judicial powers which prevails in our Constitution was the direct result of the teaching of the *Esprit des Lois.*

The following minor communications were presented by:

(2) MR. HENRY AMMON JAMES, on American Socialism.

He explained the origin and purposes of socialistic agitators in Germany and in the United States; discussed socialistic methods of working upon the laboring classes; and showed the slender chances of socialism in this country, where the ownership of land is so widely distributed, and where the attainment of property or station causes even socialistic leaders to desert their cause. Mr. James narrated his personal experience among the leaders of these movements, and in conclusion reviewed a recent German monograph, by Dr. Henry W. Farnam, on *Amerikanische Gewerkvereine*, a field hitherto unexplored by scientific economists.

(3) A review of Von Holst's Constitutional and Political History of the United States was made, at the request of the Association, by HON. GEORGE WM. BROWN.

December 12, 1879. Forty persons present.

(1) The principal communication of the evening was by REV. EDWARD EVERETT HALE, D. D., of Boston, on The Early Cartography of America.

The view of Henry Stevens, that the early discoverers regarded the North American continent as the continuation of the Asiatic coast-line, was expounded and sustained, and the development of the geographical idea of the New World graphically illustrated. A discussion followed, and inquiries were made concerning Lionardo da Vinci's map, whereon the name America first occurs, being, however, applied only to South America.

Minor communications were made by:

(2) PRESIDENT GILMAN, on a visit to St. Dié, in 1875.

St. Dié is a town in the Vosges Mountains, where, in 1507, the name America was suggested by a school of geographers in their *Cosmographiae Introductio.*

(3) DR. H. B. ADAMS, on a Map of the Salem Common Lands.

This map he had caused to be made at the Essex Institute, in Salem, Massachusetts, to illustrate his forthcoming paper on Land Community in America. Some new sources of Town History were also discussed.

(4) DR. E. E. HALE, on Oliver Pollock, a patriot of the Revolution.

After adjournment, an informal reception was given Dr. Hale, in the Trustees' Room; in the course of which he gave a short account of Oliver Pollock, at one time a resident of Baltimore, who furnished, at his own expense, large quantities of powder to the Revolutionary forces, and yet has no fame or place in Maryland history or in American biography. Dr. Hale had found some of Pollock's letters among the papers of the late Jared Sparks, (who was for a time a clergyman in Baltimore), and he had lately continued this biographical inquiry at the Maryland Historical Society, where, by the aid of Mr. Lee's classification of Congressional documents, the "*Claims of Oliver Pollock*" against the United States Government were found in published from, and are now known to have been settled by Congress. In his prime, Oliver Pollock appears to have been a sturdy, unselfish character. On one occasion he paid out silver dollars for Continental paper, in order to restore confidence in our governmental credit among the Spaniards of the south.

January 6, 1880. Forty-eight persons present.

A special meeting of the Association was held to listen to a communication from PROF. JUSTIN WINSOR, late of the Boston Public Library, and now Librarian of Harvard College. He was present, by invitation of the Association, at the suggestion of Rev. E. E. Hale, to continue the discussion of Early American Cartography, which was introduced at the previous meeting.

His remarks were illustrated by a series of thirty diagrams of large size, arranged continuously on a roller, and copied from the oldest records of geographical discovery upon the Atlantic Coast of America.

List of the Diagrams.

(1) *Sigurd*, (voyage 1000), 1570 in Sylvanus; (2) *Zeno*, (voyage 1380-90), 1558; (3) *Behaim*, 1492; (4) *Juan de la Cosa*, 1500; (5) *Reinel*, 1505; (6) *Ruysch*, 1508, (He probably accompanied Cabot); (7) *Waldseemüller*, 1507, (map to Ptolemy, ed. 1511); (8) *Lenox Globe*, 1510-12; (9) *Peter Martyr*, 1511; (10) *Sylvanus*, (map to Ptolemy), 1511; (11) *Lionardo da Vinci*, 1513-14, (first use of word "America" on a map; the significance of this map was first noticed in 1865); (12) *Stobnicza*, 1512-20; (13) *Portuguese map*, 1514-20; (14) *Schoner*, 1520, (New set of coast names); (15) *Camer's* map to Solinus Polyhistor, 1520, (Name "America" first engraved); (16) *Fries*, 1522, (map to Ptolemy); (17) *Thorne*, 1527; (18) *Verrazano*, 1529; (19) *Rivero*, 1529; (20) *Finæus*, 1531, Globe, (map taken from globe on Mercator's projection): (21) *Venetian map* (wood-cut, now in Lenox collection); (22) *Map to Ptolemy*, 1540; (23) *Mercator*. 1541; (24) *Ulpius*. 1542; (25) *Map made by order of Francis I. for the Dauphin*, 1543; (26) *Ruscelli*, 1544, (British Museum); (27) *Cabot*, (?) 1544, (unique copy discovered in Germany, now in Paris); (28) *Gastaldi*, 1550; (29) *Homem*, 1558, (Portuguese, in British Museum; (30) *Mercator*, 1569.

In exhibiting these diagrams the speaker commented on their origin and interpreted their significance with many important original observations.

After adjournment to the Library, an informal reception was given to Prof. Winsor. Among other visitors, Prof. Gibbs of Yale College, Prof. W. E. Griffis, late of the University of Tokio, in Japan, Dr. Bessels, the Arctic explorer, and Prof. Means of Middlebury College, were present.

In response to a call upon Prof. Winsor for some of his views in respect to Lending Libraries, he briefly told the history of the Boston Public Library, and considered the best methods to be pursued in the foundation of a lending library in Baltimore.

Philological Association.

SEVENTEENTH MEETING. *October* 10, 1879.

(1) An account of the scope, methods and history of the Association was given by the President, PROFESSOR GILDERSLEEVE.

(2) The principal paper, by PROFESSOR GILDERSLEEVE, discussed The Encroachments of *μή* upon *οὐ* in later Greek.

The later use of *μή* is not so much an innovation as an extension, and the lines of intrusion are first *μή* with infinitive in *oratio obliqua*—then *ὅτι μή* with the finite verb as a form of *oratio obliqua*, the causal, the relative sentence, and, especially characteristic of the development of the doctrine, the participle. [See Am. Philol. Assoc. Proc. 1879.]

(3) PROFESSOR ELLIOTT presented a communication upon *La vie d'Alexis*, and the Theory of M. Gaston Paris concerning the Distribution of the North French Dialects.

This paper considered G. Paris' *Neustrian* Dialect-theory. It was claimed that phonetics do not justify it, so far as the above work is concerned, and that the *Vie d'Alexis* belongs to pure Norman.

(4) PROFESSOR LANMAN discussed the question, Why has the Sanskrit Ablative so seldom a Form exclusively its own?

As shown by actual count of all the cases in the Rigvedasanhita, the ablative relation requires expression less frequently than any other whatsoever. It is therefore entirely in accord with the principle of linguistic economy that it should have no form devoted exclusively to its own use, but should be made to depend for its expression upon the case-form of the genitive or dative.

(5) PROFESSOR BRANDT reported on the *Germania* (xxiv. 3), and on the *Zeitschrift für deutsche Philologie* (x. 4).

Twenty-two persons were present.

EIGHTEENTH MEETING. *November* 7, 1879.

(1) The principal paper was by PROFESSOR LANMAN, On the relative Frequency of ancient and modern grammatically equivalent Forms as a Criterion of the Age of different Vedic Texts.

The investigation showed that as between the Rigveda and the Atharvaveda this criterion furnishes most striking results respecting the antiquity of the former and comparatively modern date of the latter. As between the different collections of the Rigveda—negatively, the family books ii.-vii. are of about the same age; positively, a chronological arrangement of four books may be made as follows: viii., ix., vii., and x. The most striking results for the Rigveda would be obtained, not on the basis of a division into books, but into batches of fragments and portions whose lateness is shown by contents, vocabulary, etc.

(2) **Professor Cook** followed with a minor communication, On the Word *weasand*.

He showed that the word *weasand* is derived, through the Anglo-Saxon *wásend*, from the verb *hwæsan*, 'wheeze,' other instances of the aphaeresis of *h* in Anglo-Saxon being brought forward to support the theory.

(3) **Professor Lanman** read a paper On Races of which the Men speak a Dialect different from that of the Women.

The women of certain Caribbean tribes have a speech of their own. In the Sanskrit dramas the women always speak Prakrit. An historical explanation of these facts was attempted.

(4) **Professor Morris** discussed Some Verbal Forms in Homer.

He described the attempt of Savelsberg, approved by Ameis, to show that such forms as ἀνέσει are real subjunctives of the indicative aorists in -κα. The attempt appeared to him unsatisfactory.

Eighteen persons were present.

Nineteenth Meeting. *December* 5, 1879.

(1) The principal communication of the day was by **Professor Warren**, On the Origin of the Nasal in the Greek Indefinite Pronouns.

This paper endeavored to show that the ν in the indefinite and interrogative pronouns is not of purely euphonic origin, but a remnant of the same pronominal stem which is seen in the Greek νή, ναί, Latin *nē*, *nam* (*quisnam*), Zend *na* (*kaçna*, *cinem*), and in the Sanskrit comparative particle *ná*, which Max Müller and other scholars erroneously identify with *ná*, the particle of negation.

(2) **Professor Elliott** discussed The Latest Theories respecting the Language of the *Serments de Strasbourg*.

This paper made a general review of the theories in historic order. The "border-land" set was specially criticised. It was argued that phonetics and historic evidence both show that the centre of France was the home of the language of the *Serments*.

(3) **Dr. John Sundberg** gave an Account of the Customs and Language of the Santals.

The Santals are a wild tribe of Dravidian origin, living in the Rajmahal mountains, in Bengal. The account was based on personal experience and observation.

(4) **Mr. Allinson** read a paper On Πίαρ as an Adjective.

He showed by the history of this word and its etymological congeners the *a priori* probability of its use as an adjective, and confirmed the same by the exegesis of a number of Greek passages.

Twenty-nine persons were present.

Metaphysical Club.

First Meeting. *October* 28, 1879. Sixteen persons present.

(1) **Mr. C. W. Nichols** read a paper on the Metaphysical Fallacy, especially as illustrated by the Greek Philosophers.

This paper pointed out several notable instances in which the ancients had mistaken grammatical for real analogies.

(2) **Mr. B. I. Gilman** stated and defended the Doctrine of Limits.

(3) **Mr. Gantt** considered the difference between the Calculus of Leibnitz and that of Newton.

(4) **Mr Pratt** presented a communication on Zeno's Four Arguments against Motion.

(5) A paper by **Miss Ladd**, on the Non-Euclidean conception of Space, was read by Mr. Peirce.

Assuming that we know nothing of the actual construction of space, it was shown that Euclid entertained but one mode of representing it; and that by using the classification of curves of the second degree, three modes representing space might be entertained, thus giving rise to the Euclidean or Parabolic geometry, and to two Non-Euclidean, the Elliptic and Hyperbolic geometries.

(6) **Mr. Marquand** (appointed to speak against the Doctrine of Limits) attacked both the statement and the proof of the doctrine as given by Dr. Whewell.

Second Meeting. *November* 11, 1879. Twelve persons present.

(1) The principal paper, by **Mr. Peirce**, was on Questions concerning certain Faculties claimed for Man.

These questions related to the hypothesis of intuitive faculties, against which it was maintained that we have a variety of facts, all of which are most readily explained on the supposition that we have no intuitive faculty of distinguishing intuitive from mediate cognition; that there is no necessity of supposing an intuitive self-consciousness, since self-consciousness may easily be the result of inference; that we have no intuitive power of distinguishing between the subjective elements of different kinds of cognitions; that there is no reason for supposing a power of introspection, and consequently the only way of investigating a psychological question is by inference from external facts; that every thought must be interpreted in another, or that all thought is in signs; that cognition arises by a *process* of beginning, as any other change comes to pass. (The views here given have also been presented by the author of this paper in the Jour. of Spec. Philos. Vol. II.)

(2) **Mr. B. I. Gilman** presented a translation of Leibnitz's *Meditationes de Cognitione, Veritate et Ideis*.

(3) **Mr. Marquand** read a paper on the Determinate Form of the Logical Copula.

Several advantages were pointed out which arise from the assumption of copulas with definite meanings.

READINGS IN FRENCH LITERATURE.

Prof. Rabillon at an early day will begin the reading of classical French authors, with brief expository comments, (*in French*). This course is designed chiefly for members of the University.

READINGS IN ENGLISH LITERATURE.

Mr. Sidney Lanier, Lecturer in English Literature, will give ten expository readings of Chaucer's Knight's Tale and Shakspere's Midsummer Night's Dream in connection, beginning in the middle of January, at an hour and place to be designated on the bulletin.

This course is intended only for the members of the University, and especially for those whose principal studies are directed to other subjects, and who have consequently but little time at command for English Literature.

The aim of the lecturer will be to awaken an interest in the poems under review solely as works of art. The course will embrace a wide range of considerations bearing upon this end.

The instructor will take pleasure in giving three or four preliminary sessions to students unacquainted with Fourteenth Century English, for the purpose of familiarizing them with the archaic forms of Chaucer.

BALTIMORE ATHLETIC CLUB.

At a meeting of the Directors of this Club, held on December 1, 1879, the following resolution was passed:

Resolved, That students of the Johns Hopkins University, who may desire to become members of this Club, be admitted as such, (provided they are non-residents of this city,) upon payment of the regular monthly dues, and without the payment of initiation fee.

The Club has large, and well kept rooms at No. 21 North Charles Street, which are equipped with all the appliances necessary in connection with a first-class gymnasium, and which are open daily.

Any member of the Club, upon payment of $1.00 per month dues, is entitled, free of extra charge, to the use of the gymnasium, and all the apparatus, and to instruction in using the same; in addition to which, during the past year, outdoor sports have been added to the Club for the use of members.

The officers for the current year are, **J. D. Iglehart**, President; **J. Harry Lee**, Vice-President; **John N. Steele**, Treasurer; **Josias Pennington**, Secretary.

Members of the University can obtain further information from **Mr. H. F. Reid**, one of the Directors of the Club.

AMERICAN JOURNAL OF MATHEMATICS.

The current number of the *American Journal of Mathematics*, which is published under the auspices of the Johns Hopkins University, contains an account of a fundamentally new phenomenon in electricity, not explicable by anything hitherto known. The definition of the new action is not yet certainly made out; but it appears to be that if we say that the direction of a galvanic current is from the negative to the positive pole, then a magnet tends to deflect the current within the conductor in the same direction in which it tends to turn the conductor itself. This fact will be a complete surprise to physicists, and its importance to the theory of electricity can hardly be overestimated. The discoverer is Mr. E. H. Hall, assistant in the Laboratory of Professor Rowland, to whose encouragement and assistance the discovery was in a large measure due. It may justly be said that no discovery equally fundamental has been made within the last fifty years. Discoveries so novel have usually been in some degree the result of accident; but in this case elaborate and very delicate experiments were undertaken to ascertain whether or not any such phenomenon could be observed. The new force is exceedingly feeble, so that we cannot predict any practical applications for it.

The same number of the *Journal* contains several other important papers, including three by the celebrated algebraist Sylvester. All of these afford salient examples "of the importance of the part played by the *faculty of observation* in the discovery of pure mathematical laws." There has been, perhaps, no other great mathematician in whose works this is so continually illustrated as in those of Professor Sylvester. An example of a mathematical proposition known to be true many years before any one succeeded in producing a demonstration of it, is the familiar fact that on any possible map, however complicated, the different countries may be distinguished from those which adjoin them by painting them in only *four* different colors. This has been known for a long time, but the first proof of it is given in the present number of the *Journal* by Mr. A. B. Kempe, well known for his investigations into linkage. The number also contains an explanation of the "curved ball" of the base-ball players, and a method for representing a space of four dimensions.—*The Nation*, New York, December 25, 1879.

HISTORY OF PHILOSOPHY; AND ETHICS.

Professor George S. Morris.

Instruction in these subjects will be given during the last half of the academic year, and will include: (*a*) a course of public lectures; (*b*) critical and expository lectures for students of the University; and (*c*) private readings and examinations.

A. *Public Lectures.*

The public course will be on British Thought and Thinkers.

[A full statement of this course is given under Hopkins Hall Lectures on page 15.]

B. *Lectures for Special Students.*

For special and advanced students, expository and critical lectures on the History of British Philosophy, on Tuesdays, Wednesdays and Thursdays, at 4 P. M., beginning February 24, 1880. Undergraduate students previously instructed in Logic and Psychology, who shall follow this course and pass a satisfactory examination on the general subject-matter of the same, and also upon some one or more of the masterpieces belonging to the history of British Philosophy, (for example, Bacon's Novum Organum, Locke's Essay, Berkeley's Principles and Siris, Hume's Treatise, Reid's Intellectual Powers, Hartley on Man, James Mill's Analysis, Sir William Hamilton's Metaphysics, the Logic of John Stuart Mill, or the like), may be credited with the completion of a Minor Course.

C. *Private Readings.*

Readings and Discussions in Ethics. One session of two hours every Friday (or Saturday), beginning February 27, 1880.

Topic:—Kant's Critique of Practical Reason, with references to current works on Ethics.

Private reading of other philosophical works will also be directed by Professor Morris, with or without reference to the University Examinations.

Heretofore instruction has been given by the same Professor in courses of public lectures only, viz.: in 1878, twenty lectures on the General History of Philosophy, ancient and modern; and in January, 1879, fourteen lectures on selected topics in the History and Theory of Ethics.

The line of instruction here announced will be continued in 1880–81 by lectures, public and private, on German Philosophy, and in 1881-82 by lectures on Systematic Ethics, and on some phase of the History of Ancient Philosophy.

BRIEF ANNOUNCEMENTS.

Professor J. Willard Gibbs, of Yale College, began his course of instruction in Theoretical Mechanics, Wednesday, Jan. 7. His lectures are given four times a week, on Mondays and Fridays, at 10 A. M., and on Tuesdays and Thursdays at 11 A. M, in Room No. 16.

Professor Gibbs has taken a room at No. 132 West Madison St., where he may be found, usually, between the hours of two and three in the afternoon.

Dr. Minton Warren, Associate in Latin, will begin, on Saturday, January 10, at 11 A. M., a course of twelve lectures, (heretofore announced,) on Historical Latin Grammar, with special reference to the genesis of forms and to phonetic laws. This course is intended for students interested in Comparative Philology.

Mr. Edward C. Harding, (A. M., University of Virginia, 1876), late Fellow in Greek of this University, has entered upon his duties as Professor of Greek and English, in the University of Louisiana.

The Thesis of Dr. Henry C. Adams, presented when he graduated as Doctor of Philosophy in the Johns Hopkins University, has been printed in successive numbers of the Zeitschrift für die gesammte Staatswissenschaft, Tübingen, 1879. Its title is *Zur Geschichte der Besteuerung in den Vereinigten Staaten von Amerika in der Periode von* 1789–1816.

The average attendance upon Mr. Lanier's course of sixteen lectures on English Verse, especially Shakspere's, (October 28–December 19, 1879) was 170; and upon M. Rabillon's course of twelve lectures (in French) on French Epic Poetry, especially the *Chanson de Roland* (November 3–December 15), was 57.

Mr W. Mager, who has been a student in the chemical laboratory for the past two and a half years, has just accepted a position as assistant at the Agricultural Experiment Station of North Carolina, and will enter upon his duties at once. During the present academic year he has been engaged as private assistant of Prof. Remsen in carrying on an investigation on "The best method of determining the amount of organic matter in the air," undertaken at the desire of the National Board of Health. A preliminary report of this investigation has been sent to the Board, and will appear as an appendix of the annual report of the Board to Congress.

Mr. H. J. Rice, (S. B., Cornell), late Fellow in Biology here, contributes to the current number of the American Naturalist, (January 1880), an article entitled, "Observations upon the Habits, Structure and Development of Amphioxus Lanceolatus."

The candidates for the Baccalaureate Degree were assembled in Hopkins Hall on Saturday, December 20, 1879, to listen to a connected statement, from the President of the University, on the plans of undergraduate study, and of examinations as now arranged in this institution.

Professor Acland gave, in a public lecture, on Wednesday last, an account of the new Hospital at Baltimore, United States, and of its relations to the studies of the Johns Hopkins University and to medical education in the United States generally. [Oxford, December 1.]—*The Times*, London, December 2, 1879.

AMERICAN JOURNAL OF PHILOLOGY.

Edited, with the co-operation of leading scholars, by B. L. Gildersleeve, Professor of Greek in the Johns Hopkins University.

This Journal will be open to original communications in all departments of Philology, classical, comparative, oriental and modern; yet a large portion of the space will be given up to condensed reports of current philological work, and arrangements have been made to present regularly summaries of the chief articles in the leading philological journals of Europe, while a close watch will be kept over the fragmentary and occasional literature to which the isolated American scholar seldom has full access. The reviews of books will be intrusted as far as possible to specialists; and it is hoped that the Journal will meet a want that has long been acknowledged among American scholars, and serve as a means of inter-communication and as an organ of independent criticism.

The Journal will be in the ordinary review form, four numbers to constitute a volume, of from 400 to 500 pages, one volume to appear each year.

The subscription price will be three dollars a year, payable upon the receipt of the first number.

Vol. I. No. I. is now in press and will contain original articles by Goodwin of Harvard, Carter and Packard of Yale, Lanman of the Johns Hopkins University, Merriam of Columbia College, T. Davidson of Boston, and the Editor, besides reviews of books and notices of journals by well-known specialists. Articles have been promised for early numbers by Short of Columbia, Garnett of Annapolis, F. D. Allen of Yale, Morris, Brandt and Elliott of the Johns Hopkins University.

All communications should be addressed to the Editor.

AMERICAN CHEMICAL JOURNAL.

Edited, with the aid of Chemists at Home and Abroad,

By IRA REMSEN, Professor of Chemistry in the Johns Hopkins University.

Contains original articles by American and foreign chemists; reviews of works relating to chemical science; reports on progress in the various departments of Chemistry; and items of general interest to Chemists.

Published in numbers of from 64 to 80 pages; six numbers forming a volume of from 400 to 500 pages.

Price for the volume $3.00; single numbers 50 cents.

Subscriptions and communications should be addressed to the Editor.

CONTENTS FOR DECEMBER 1879, Vol. I. No. V.

On the Synthesis of Helicin and Phenolglucoside, by A. Michael.

On a New Formation of Stilbene and some of its Derivatives, by A. Michael.

On a New Method for the Separation and Subsequent Treatment of Precipitates in Chemical Analysis, by F. A. Gooch.

On Several Spanish Minerals, by F. A. Genth, Jr.

A Method for Estimating Bismuth Volumetrically, by M. Kuhara.

New Results in Electrolysis, by Edgar F. Smith.

Nitrosulphobenzoic Acids and some Derivatives, by Edward Hart.

Reports, Notes, &c., by J. W. Mallet, H. N. Morse, the Editor and others.

AMERICAN JOURNAL OF MATHEMATICS.

PURE AND APPLIED.

Editor in Chief, J. J. Sylvester, Professor of Mathematics; Associate Editor in Charge, William E. Story, Associate in Mathematics; with the co-operation of Simon Newcomb, H. A. Newton and H. A. Rowland.

Issued under the auspices of the Johns Hopkins University.

Published in the quarto form and in numbers appearing four times a year. Subscription price per Volume, of about 384 pages, $5.00; price per number $1 50. Vol. I, 1878–79 (388 pp., 4 plates) can still be furnished at the subscription price.

All communications should be addressed to the Associate Editor in charge.

CONTENTS FOR DECEMBER, 1879, Vol. II. No. 3.

1. On the Geographical Problem of the Four Colours, by A. B. Kempe, London, England.
2. Note on the Preceding Paper, by William E. Story.
3. The Quaternion Formulae for Quantification of Curves, Surfaces and Solids, and for Barycentres, by W. I. Stringham, Fellow of Johns Hopkins University.
4. On the Dynamics of a "Curved Ball," by Ormond Stone, Cincinnati, O.
5. Note on Determinants and Duadic Synthemes, by J. J. Sylvester.
6. Tables of Generating Functions and Groundforms for the Binary Quantics of the First Ten Orders, by J. J. Sylvester, assisted by F. Franklin, of the Johns Hopkins University.
7. Note on the Projection of the General Locus of Space of Four Dimensions into Space of Three Dimensions, by Thomas Craig, Fellow of Johns Hopkins University.
8. On the Motion of an Ellipsoid in a Fluid, by Thomas Craig, Fellow of Johns Hopkins University.
9. A New Proof of the Theorem of Reciprocity, by Dr. Julius Petersen, Copenhagen, Denmark.
10. On a New Action of the Magnet on Electric Currents, by E. H. Hall, Fellow of Johns Hopkins University.
11. On Ternary Cubic-Form Equations. Chapter I. On the Resolution of Numbers into Sums and Differences of Two Cubes, by J. J. Sylvester.

STUDIES FROM THE BIOLOGICAL LABORATORY.

Edited by H. NEWELL MARTIN, Professor of Biology.

CONTENTS OF No. 2, 1880.

I. On the respiratory function of the internal intercostal muscles. By H. Newell Martin and Edward Mussey Hartwell.

II. Observations on the physiology of the spinal cord. By Isaac Ott.

III. On the effect of two succeeding stimuli upon muscular contraction. By Henry Sewall.

IV. On the so-called heat dyspnœa. By Christian Sihler.

V. A self-feeding chronograph pen. By H. Newell Martin.

VI. Observations upon the early stages in the development of the fresh water pulmonates. By W. K. Brooks.

VII. The development of *amblystoma punctatum*. By S. F. Clarke.

Price per number $1.00.

No. I, 1879, (91 pp, 4 plates) can still be furnished.

All communications should be addressed to the Editor.

Copies of the Johns Hopkins University Circulars may be obtained, as soon as published, of Messrs. CUSHINGS & BAILEY, *No.* 262 *West Baltimore Street, Baltimore. Price* 5 *cents each.*

NEW-YORK

[This Number is especially devoted to Mathematics and Physics.]

JOHNS HOPKINS UNIVERSITY CIRCULARS.

Published with the approbation of the Board of Trustees.

No. 3.] BALTIMORE, FEBRUARY, 1880. [Price 5 Cents.

CALENDAR.

February 10—March 30.	**Dr. Adams's Course on the Italian Renaissance, etc.**
February 16—March 19.	**Dr. Lanman's Course on the Vedas.**
February 18—May 5.	**Professor Gildersleeve's Readings in the Greek Tragic Poets.**
February 21—April 24.	**M. Rabillon's Readings (in French) in French Literature.**
February 23.	**Fourth Anniversary of the University.**
February 23—May 3.	**Prof. Morris's Course on British Thought and Thinkers.**
February 24-26.	**Lectures on Celestial Chemistry, at the Peabody, by Prof. G. F. Barker.**
March 2-4.	**Lectures on Color Blindness, at the Peabody, by Dr. B. J. Jeffries.**

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MEETINGS OF SOCIETIES, Etc.

Scientific. First Wednesday of each month, at 8 P. M. Next meeting, March 3. S. F. Clarke, Sec'y.

Philological. First Friday of each month, at 12 M. Next meeting, March 5. C. R. Lanman, Sec'y.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, March 19. H. B. Adams, Sec'y.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, March 9. Allan Marquand, Sec'y.

Biological. Thursday of each week, at 4 P. M.

Mathematical Seminary. Third Wednesday of each month, at 8 P. M. Next meeting, March 17.

Greek Seminary. Wednesday of each week, at 12 M.

PUBLIC LECTURES.

Lectures are in progress in Hopkins Hall at 5 P. M.:

Prof. Morris, Mondays, till May 3.

Dr. Adams, Tuesdays, till March 30, and Thursdays, March 18 and 25.

Prof. Gildersleeve, Wednesdays, till May 5.

Dr. Lanman, Thursdays, till March 11, and Friday, March 19.

M. Rabillon, Saturdays, till April 24.

MATHEMATICS AND PHYSICS,

1876-80.

The following statements are brought together in a connected form, so that students who desire to devote their time to Mathematics and Physics may see what opportunities are offered in the Johns Hopkins University.

Although the precise courses to be given in the future are not stated, there is every reason to believe that they will be at least as varied and advanced as heretofore; and that students residing here for two or three years will have the opportunity to pursue the study of Mathematics and Physics, *in any direction which they may choose*, under competent guidance, and with the requisite books and apparatus.

The organization of this part of the University has been directed in Mathematics by Professor SYLVESTER, LL. D., F. R. S., formerly of London and Woolwich, and in Physics by Professor ROWLAND, and by their Associates, W. E. STORY, Ph. D., and C. S. HASTINGS, Ph. D. Lectures have also been given by non-resident professors, who have likewise rendered aid in the mathematical and physical examinations; and there have been several assistant instructors and private teachers acting under the general guidance of the professors.

The advancement of mathematical and physical studies is here promoted by the following agencies:

1. *Courses of Lectures and Class-Room Instructions*, covering the most important subjects in Pure and Applied Mathematics, including Analytical Mechanics, and Physics. Some of these courses will be repeated annually, and others will be given as they may be called for by students. The annual programmes contain detailed announcements.

2. *Mathematical Seminary*. The students of Mathematics are accustomed to meet Professor Sylvester and Dr. Story in monthly assemblies, known as meetings of the "Mathematical Seminary." At these meetings, besides occasional papers, such topics as may from time to time suggest themselves in the course of reading of the students or instructors, or may otherwise be of general interest to persons pursuing mathematical studies, are discussed.

The results of special studies upon the following subjects, among others, were examined during the last academic year:

Newton's rule for the limit of roots of algebraic equations.—The rule of signs in trigonometry.—Barycentric co-ordinates.—Double points of plane curves.—The quasi evolute.—Central harmonic transformation.—Special cases of Pascal's hexagram.—Transformation by elliptic co-ordinates.—Regular figures in space of n dimensions.

3. *Physical Journal Society*. The physicists hold a weekly meeting under the direction of Professor Rowland and Dr. Hastings, for the purpose of reviewing the recent numbers of journals devoted to Physics.

4. *Johns Hopkins Scientific Association*. A meeting of this Association is held monthly, at which an opportunity is afforded for communicating abstracts of recent mathematical and physical progress, as well as the results of individual research.

5. *American Journal of Mathematics*. The University encourages the publication of papers on scientific subjects produced by its members. Some of these are printed in the American Journal of Mathematics, published under the auspices of the University, and others appear elsewhere. A partial list of these papers is appended.

6. *Apparatus*. Additions are constantly made to the physical apparatus, which is already extensive, and is especially adapted to researches in Heat, Electricity, and Magnetism. The University employs a skilled mechanician in the manufacture and repair of instruments of precision.

7. *Books and Periodicals*. In the Peabody and Hopkins Libraries may be found the Transactions of learned Societies, complete sets of the Philosophical Magazine, Crelle, Liouville, Grunert, Poggendorff, Dingler, etc. A list of the periodicals currently received is appended.

8. *Fellowships*. Among the twenty fellowships of the University, each yielding five hundred dollars annually, three are ordinarily held by mathematical, and three by physical students.

INSTRUCTORS AND STUDENTS.

Professors, Associates, and Lecturers.

J. J. SYLVESTER, *Professor of Mathematics.*
A. M., University of Cambridge; F. R. S., London and Edinburgh; Corresponding Member Institute of France; Member Academy of Sciences in Berlin, Göttingen, Naples, Milan, St. Petersburg, etc.; LL. D., University of Dublin, University of Edinburgh; late Professor of Mathematics in the Royal Military Academy, Woolwich.

WILLIAM E. STORY, *Associate in Mathematics.*
A. B., Harvard University, 1871; Ph. D., University of Leipsic, 1875; Tutor of Mathematics in Harvard University, 1875-76.

HENRY A. ROWLAND, *Professor of Physics.*
C. E., Rensselaer Polytechnic Institute, Troy, 1870; Assistant Professor in the same, 1872-75.

CHARLES S. HASTINGS, *Associate in Physics.*
Ph. B., Yale College, 1870, and Ph. D., 1873; Holder of the Tyndall Scholarship in Paris, 1875.

CHARLES S. PEIRCE, *Lecturer on Logic.*
A. B., Harvard College, 1859, A. M., and S. B., 1863; of the U. S. Coast and Geodetic Survey.

THOMAS CRAIG, *Lecturer on Mathematics.*
C. E., Lafayette College, 1875; Ph. D., Johns Hopkins University, 1878; of the U. S. Coast and Geodetic Survey.

J. WILLARD GIBBS, *Lecturer on Mechanics.*
A. B., Yale College, 1858; A. M., and Ph. D., 1863; Professor in Yale College.

FABIAN FRANKLIN, *Assistant in Mathematics.*
Ph. B., Columbian University, 1869.

Public Lectures have also been given by:

PROFESSOR SIMON NEWCOMB, of the U. S. Naval Observatory. *History of Astronomy*, (1876-77);

PROFESSOR J. E. HILGARD, of the U. S. Coast and Geodetic Survey. *On Geodetic Surveys*, (1876-77);

PROFESSOR JOHN TROWBRIDGE, of Harvard University, *Philosophy of Physics*, (1879-80).

Students.

The following list includes the names of those only who have made Mathematics or Physics their principal study:

NEWTON M. ANDERSON, (from Columbus, O., Ohio State University; Massachusetts Institute of Technology).

BROWN AYRES, (from New Orleans, La.; Washington and Lee University; S. B., Stevens Institute of Technology, 1878; Graduate Student, Johns Hopkins University, 1878-79). *Fellow in Physics.*

GUSTAV BISSING, (from Baltimore; Baltimore City College).

JOHN C. BLAND, (from Washington, D. C.; C. E., American Institute of Civil Engineers). *Office of the Supervising Architect of the Treasury, Washington, D. C.*

JOHN W. BROWN, (from Govanstown Md.; Mr. G. G. Carey's School).

ROBERT J. COLEMAN, (from Fayette, Mo.; A. B., Central College, Mo., 1875).

CHARLES M. CONE, (from Hartford, Vt.; S. B., Dartmouth College, 1875).

THOMAS CRAIG, (from Pittston, Pa.; C. E., Lafayette College, 1875; Ph. D., Johns Hopkins University, 1878, and Fellow in Mathematics and Physics, 1876-79). *U. S. Coast and Geodetic Survey, Washington, D. C.; Lecturer on Mathematics.*

H. ROZIER DULANY, (from Upperville, Va.; University of Virginia, 1878). *Instructor in Mathematics in Mr. G. G. Carey's School, Baltimore.*

BURR K. FIELD, (from Mt. Washington, Md.; Ph. B., Yale College, 1877). *Engineer Corps, St. L. & S. F. R. R., Wichita, Kansas.*

LAWRENCE B. FLETCHER, (from Marlboro', N. Y.; A. B., Columbia College, 1877, and Fellow of Science, 1877-80).

FABIAN FRANKLIN, (from Baltimore, Md.; Ph. B., Columbian University, 1869; Graduate Student, Johns Hopkins University, 1876-77, and Fellow in Mathematics, 1877-79). *Assistant in Mathematics.*

SPENCER H. FREEMAN, (from Penfield, N. Y.; A. B., University of Rochester, 1875, and A. M., 1878).

HENRY L. GANTT, (from Owings Mills, Md.; McDonogh School).

JOSHUA W. GORE, (from Frederick County, Va.; C. E., University of Virginia, 1875; Fellow in Mathematics, 1876-78). *Professor of Natural Science, Southwestern Baptist University, Jackson, Tennessee.*

EDWIN H. HALL, (from Gorham, Me.; A. B., Bowdoin College, 1875; Graduate Student of Physics, Johns Hopkins University, 1877-78). *Fellow in Physics.*

GEORGE B. HALSTED, (from New York City; A. B., Princeton College, 1875; Ph. D., Johns Hopkins University, 1879, and Fellow in Mathematics, 1876-78). *Tutor in Princeton College.*

ARTHUR S. HATHAWAY, (from Ithaca, N. Y.; S. B., Cornell University, 1879). *Teacher of Mathematics in Mr. E. M. Lamb's School, Baltimore.*

DANIEL W. HERING, (from Mechanicstown, Md.; Ph. B., Yale College, 1872, and C. E., 1878; Fellow in Engineering, Johns Hopkins University, 1876-78). *Assist. Engineer, B. & C. V. R. R., Waynesboro', Pennsylvania.*

MAXWELL S. HUDGINS, (from Matthews Court House, Va.; C. E., Washington and Lee University, 1876). *Teacher of Mathematics, Dabney University School, New York City.*

WILLIAM W. JACQUES, (from Newburyport, Mass.; S. B., Massachusetts Institute of Technology, 1876; Ph. D., Johns Hopkins University, 1879, and Fellow in Physics, 1876-79).

JAMES E. KEELER, (from Mayport, Fla.; La Salle (Ill.) High School).

C. HERSCHEL KOYL, (from London, Ontario; A. B., Victoria University, (Ont.), 1877).

WILLIAM S. MARSTON, (from Cambridge, Mass.; A. B., Harvard University, 1874). *Private Teacher of Mathematics, Baltimore.*

OSCAR H. MITCHELL, (from Marietta, O.; A. B., Marietta College, 1875, and A. M., 1878; Graduate Student, Johns Hopkins University, 1878-79). *Fellow in Mathematics.*

WILLIAM S. MOORE, (from Rock Hill, S. C.; A. B., Davidson College, 1877).

EDWARD L. NICHOLS, (from Peekskill, N. Y.; S. B., Cornell University, 1875; Ph. D., University of Göttingen, 1879). *Fellow in Physics.*

CHALMERS C. NORWOOD, (from Fort Valley, Ga.; A. B., Davidson College, 1878).

JAMES PAGE, (from Baltimore; Baltimore City College).

ROBERT W. PRENTISS, (from New Brunswick, N. J.; S. B., Rutgers College, 1878; Graduate Student, Johns Hopkins University, 1878-79). *Fellow in Mathematics.*

PHILIP M. PRESCOTT, (from Waukegan, Ill.; Chandler Sc. Dept., Dartmouth College).

E. DARWIN PRESTON, (from Spruce Grove, Pa.; B. C. E., Cornell University, 1875; Fellow in Engineering, 1876-78). *Aid, U. S. Coast and Geodetic Survey.*

HENRY F. REID, (from Baltimore; C. E., Pennsylvania Military Academy, 1876).

GEORGE L. SMITH, (from Canandaigua, N. Y.; C. E., Cornell University, 1874). *Teacher, State Normal School, Baltimore.*

WASHINGTON I. STRINGHAM, (from Topeka, Kansas; A. B., Harvard University, 1877; Graduate Student, Johns Hopkins University, 1877-78). *Fellow in Mathematics.*

WILLIAM J. THOMAS, (from Baltimore; Randolph-Macon College).

CHARLES A. VAN VELZER, (from Ithaca, N. Y.; S. B., Cornell University, 1876). *Fellow in Mathematics.*

HERMAN VOORHEES, (from Troy, N. Y.; C. E., Rensselaer Polytechnic Institute, 1873). *Deceased.*

FRANK P. WHITMAN, (from Troy, N. Y.; A. B., Brown University, 1874, and A. M., 1877; Massachusetts Institute of Technology).

LEWIS W. WILHELM, (from Baltimore; Baltimore City College, 1871).

COURSES OF INSTRUCTION.

(The number of students is given in parenthesis.)

1. **Determinants and Modern Algebra:** Professor Sylvester, 1876-77, second half-year, twice weekly, (7); 1877-78, twice weekly, (5); 1878-79, twice weekly, (8).

The course on Determinants as a connecting link between Algebra, as formerly understood, and the Modern Algebra, which has grown up in the last quarter of a century, was designed for mathematical students possessed of only an elementary knowledge of the subject.

The lectures in the session, 1876-77, were chiefly confined to this subject, that of Modern Algebra in its wider sense being only entered upon.

In 1877-79 the course in Modern Algebra was continued. This subject was developed in an original manner, the theory of differentiants being made the basis of that of invariants and covariants. In particular, the determination of the number of independent invariants and covariants of a given quantic was treated very fully.

Salmon's Modern Higher Algebra, and Faà de Bruno's *Théorie des Formes Binaires* were to some extent used as books of reference.

Many original investigations of the lecturer, including new as well as previously published matter, were incorporated into the substance of these courses; several of the former, (among which may be specified the proof of the previously undemonstrated Fundamental Theorem of the Denumeration of Invariants, brought out for the first time in the lecture-room of the University), were subsequently published in various mathematical journals.

2. **Theory of Numbers:** Professor Sylvester, 1879-80, twice weekly, (8).

The subject is treated by various methods, many of which are new and original. The course embraces a statement of the result of independent investigations by the lecturer, among which may be specified an extension of the method of Continued Fractions to Quaternions; and researches into the Divisors of Cyclotomic Functions, with applications to a new theory of cubic-form equations. Dirichlet's *Zahlentheorie*. Legendre's *Théorie des Nombres*, and Bachmann's *Theorie der Kreistheilung*, are used as books of reference.

3. **Quaternions:** Dr. Story, 1877-78, twice weekly, (2); 1879-80, thrice weekly, (4).

Text-Book: Tait's Elementary Treatise on Quaternions.

This course is designed to give a practical knowledge of the methods of quaternions; and the elementary chapters of the text-book are treated with as much brevity as is consistent with a thorough logical foundation of the subject.

4. **Elliptic Functions:** Dr. Story, 1878-79 (beginning of a two years' course), twice weekly, (2); 1879-80, thrice weekly, (4).

Text-Book: Cayley's Elementary Treatise on Elliptic Functions.

The course during the current year is a continuation of that of the last year, and presumes a knowledge of the equivalent of chapters I-IV., XII-XIII. of the text-book.

5. **Higher Plane Curves:** Dr. Story, 1878-79, first half-year, thrice weekly, (6); 1879-80, first half-year, four times weekly, (5).

Text-Book: Salmon's Higher Plane Curves.

Particular attention is paid to the general properties and methods of treatment of algebraic curves and systems of curves, so as to prepare the way for a more thorough study of special cases.

6. **Solid Analytic Geometry:** Dr. Story, 1878-79, thrice weekly, second half-year, (7); 1879-80, four times weekly, second half-year.

Text-Book: Salmon's Geometry of Three Dimensions.

An elementary course embracing quite a thorough treatment of the plane, and the more important properties of the quadric surfaces, with a free use of modern methods.

7. **Differential Equations:** Dr. Craig, 1877-78, thrice weekly, (4); Dr. Story, 1878-79, twice weekly, (5); 1879-80, thrice weekly, (8).

Text-Book: Boole's Treatise on Differential Equations.

A practical course. The second half-year is devoted especially to partial differential equations.

8. **Calculus of Variations:** Dr. Craig, 1879-80, twelve lectures, (9).

This course was designed as preparatory to that of Professor Gibbs on Rational Mechanics.

9. **Spherical Harmonics:** Dr. Craig, 1878-79, ten lectures, (6); 1879-80, twenty lectures, (6).

This course embodied a statement of the general theory of Spherical Harmonics and their application to some new problems in Hydrodynamics.

10. **Cylindric or Bessel's Functions:** Dr. Craig, 1879-80, ten lectures, (2).

An examination of their general theory and application to vortex motion in a viscous fluid.

11. **General Theory of Functions, including Riemann's Theory:** Dr. Craig, 1879-80, thirty lectures.

The general theory of functions of a complex variable, as given by Neumann his work entitled, *Riemann's Theorie*.

12. **Theory of Equations:** Dr. Story, 1876-77, twice weekly, (7); Mr. Franklin, 1877-78, twice weekly, (1); 1878-79, twice weekly, (1); 1879-80, twice weekly, (6).

Text-Book: Todhunter's Theory of Equations.

An elementary course, including the most important methods for the exact or approximate solution of algebraical equations and the determination of limits for the roots and of their reality.

13. **Definite Integrals:** Dr. Craig, 1876-77, first half-year, thrice weekly, (5).

Text-Book: Meyer's *Bestimmte Integrale*.

This was a course of lectures upon the general theory of definite integrals, particularly the Eulerian Integrals.

14. **Differential and Integral Calculus:** Dr. Craig, 1876-77, daily, (5); Mr. Franklin, 1877-78, thrice weekly, (4); 1878-79, thrice weekly, (12); 1879-80, thrice weekly, (9).

Text-Books: Williamson's Differential Calculus and Integral Calculus.

Embracing the elements of the differential and integral calculus, and the most fundamental applications to geometry.

15. **Conic Sections:** Dr. Story, 1876-77, first half-year, daily, (6); 1877-78, four times weekly, (5); Mr. Franklin, 1878-79, thrice weekly, (5); 1879-80, thrice weekly, (5).

Lectures given from notes prepared by Dr. Story.

This course is the outgrowth of a successful attempt to teach conic sections, by modern methods, from the beginning. A thorough knowledge of the analytic geometry of the straight line in rectangular co-ordinates is the only prerequisite. As a mental discipline, as well as a preparation for future geometrical studies, these methods are greatly to be preferred to the old methods still in general use in elementary text-books published in this country, however little employed in original investigations on the descriptive properties of the conics.

16. **Modern Synthetic Geometry:** Mr. Franklin, 1877-78, twice weekly, (2).

Text-Book: Mulcahy's Modern Geometry.

17. **Mathematical Astronomy:** Dr. Story, 1877-78, thrice weekly, (2).

Text-Book: Gauss' *Theoria Motus*.

18. Rational Mechanics: Professor Gibbs, 1879-80, four times weekly, during January and February, 1880, (10).

The object of this course is to develop the general principles of mechanics in their mutual connections, and to explain its most important methods. A full statement of the character of the course is made in University Circulars, No. 1, page 7.

A knowledge of the Calculus of Variations is indispensable to all pursuing this course.

19. Elementary Mechanics: Dr. Craig, 1876-77, second half-year, (8).

This course was intended especially for students beginning the study of Physics; no text-book was employed.

20. Analytical Mechanics: Dr. Craig, 1877-78, first half-year, (6).

This course was based upon Kirchhoff's *Mathematische Physik*, and principally considered the motion of a rigid body.

21. Theoretical Dynamics: Dr Craig, 1878-79, fifteen mathematical lectures, (6).

This course was based upon Jacobi's *Vorlesungen über Dynamik*. The great general principles of Dynamics were explained very fully, and Hamilton's and Lagrange's methods were discussed and illustrated.

22. Mathematical Theory of Elasticity: Dr. Story, 1876-77, twice weekly, second half-year, (4); 1877-78, twice weekly, (2).

The method of treatment employed was that of Riemann (*Differentialgleichungen*, §§79-89), with numerous applications.

23. General Physics: Dr. Hastings, 1876-77, daily; 1877-78, daily; 1878-79, daily, (13); 1879-80, daily, (15).

Text-Book: Atkinson's Ganot.

This course is given every year, and it discusses all the principal subjects in Physics, (Mechanics, Light, Sound, Heat, Electricity and Magnetism.)

There are daily lessons through the year, including every week two lectures, three recitations, and one practical lesson in the Laboratory, to which a select number of students is admitted.

24. Thermodynamics: Professor Rowland, 1876-77; 1878-79, thirty mathematical lectures, and ten conferences, (7).

This course was adapted to the use of physicists, rather than to that of those who desire to study the theory of the steam-engine only.

25. Electricity and Magnetism: Professor Rowland 1878-79, eighty mathematical lectures, and twenty-seven conferences, (3); 1879-80, twenty lectures and five conferences, (3).

In this course Maxwell's Treatise on Electricity and Magnetism was used, to some extent, as a book of reference.

26. Theory of Heat Conduction: Professor Rowland, 1879-80, three lectures and one conference weekly, (5).

The lectures are not based upon any works of reference, but the subject is treated from a new standpoint, so as to be adapted to physicists. Constant reference is made to the similarity of the subject with the theory of electricity.

27. Theory of Sound in its Relation to Music: Dr. Hastings, 1877-78, six public lectures.

These lectures, given to a general audience, brought forward, with experimental illustrations, the present state of physical investigations in respect to musical sounds.

28. Hydrodynamics: Dr. Craig, 1878-79, twenty-four mathematical lectures, (7).

The substance of this course was given a second time in eleven lectures addressed to Civil and Military Engineers.

29. Theory of Observations, and Selected Problems in Physics: Dr. Hastings, 1876-77, (3); 1877-78, 1878-79, (6); 1879-80, (9); once weekly, Saturday.

This work is planned to meet the requirements of such as are taking a major course in Physics, or who are pursuing that study as a subsidiary subject in preparation for a second degree. In this course special attention is given to the methods of discussing observations.

30. Experimental Physics: Prof. Rowland, daily; Dr. Hastings, Saturdays.

The rooms devoted to Experimental Physics are open daily from 9 A. M. to 5 P. M. They are specially adapted to those who are engaged in conducting investigations or who are training themselves to become professional physicists. In addition to these advanced students, those who are engaged in studies antecedent to medicine, and other persons, including students of Chemistry, Biology, etc., who show a special aptitude for the pursuit of Physics, have an opportunity to work in the Laboratory one day in the week.

The University is supplied with the necessary apparatus for study in any department of Physics; but for work in respect to Heat, Electricity and Magnetism, its resources are unusually good. The list subsequently given (which was originally printed, with other corresponding lists, in the Bulletin of Harvard College Library,) exhibits the character of the collection.

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31. Logic: Mr. C. S. Peirce, 1879-80, thrice weekly, (14).

A general course, treating the foundation of logic and deducing the theory of the subject from physiological facts. Subjects treated: clearness of apprehension; doctrine of limits; syllogistic (a new analysis); the doctrine of logical breadth, depth, and area; logical algebra and the logic of relatives; probabilities; theory of errors; induction and hypothesis.

A course of lectures on Mediæval Logic, designed to show the spirit and leading doctrines of the logic of the Middle Ages, was also given by Mr. Peirce.

32. Probabilities: Mr. C. S. Peirce, 1879-80.

Developing the mathematics of probabilities.

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33. History of Astronomy: Professor Newcomb, of the U. S. Naval Observatory, 1876-77, twenty public lectures.

These Lectures, (part of which were subsequently printed in a volume), were adapted to students and others who desired to become acquainted with the general progress of astronomical research, both ancient and modern. The spirit and method of the ancient Astronomy, and the steps by which the science has reached its present state of perfection were fully discussed.

34. Geodesy: Professor Hilgard, of the U. S. Coast and Geodetic Survey, 1876-77, twenty public lectures.

This course of Lectures, attended chiefly by those devoted to the pursuit of Civil Engineering, exhibited the methods and results of extended topographical surveys in Europe and America.

35. Philosophy of Physics: Professor John Trowbridge, of Harvard University, 1879-80, twelve public lectures.

This course illustrated before a general audience the modern mode of investigation respecting Heat, Sound, Light, Electricity and Magnetism, and drew attention to the Philosophy of Physics, and the importance of this branch of science.

LIST OF APPARATUS IN PHYSICS.

Designed for Scientific Researches and involving Accurate Measurement.

The University has also the apparatus requisite for demonstrations.

(Republished, with additions, from the Library Bulletin of Harvard University, No. 12, 1879.)

ACOUSTICS.

All the ordinary apparatus by Koenig of Paris, including Helmholtz's double siren, Lissajou's vibrating microscope, Hastings' pendulum comparator, &c.

OPTICS.

1. *Meyerstein Spectrometer*—large model. The circle is of 16 centimeters radius, divided on silver to 6′ and reading by two microscopes to 2″. The probable and periodic errors of graduation have been investigated, and are given in the "American Journal of Science," vol. xv. p. 270. Having a common axis with the large circle is a table rotating independently, 6.5 centimeters radius, graduated on a silver limb, and by two verniers to single minutes. The massive stand has a joint by which the circle may be brought into a vertical plane. Aperture of telescope and collimator 4.0 centimeters, focal length 34 centimeters, powers from 13 upward. A smaller telescope 2.0 centimeters aperture, 18.0 centimeters focal length, power 7, may be placed on a third support rigidly connected with the microscope bearers. The accessories of this instrument are:—

(*a*). Two telescopes with Nicol prisms before objectives: longer diagonals of prisms, 2.0 centimeters; length of telescopes, 20.0 centimeters; power, 3; position angles of prisms read by circles of 3.5 centimeters radius to minutes of arc.

(*b*). Babinet's compensator with wedge of 3 centimeters available length.

(*c*). High power collimating ocular.

(*d*). Low power collimating ocular.

(*e*). Three micrometer eye-pieces.

2. *Spectrometer*, by Schmidt and Haensch. The circle has a silver limb 16 centimeters radius, divided to 6′ and read by microscopes to 2″. Table in centre has a graduation 6.0 centimeters radius, reading by verniers to 1′. Aperture of objectives of telescope and collimator, 3.9 centimeters; focal length, 35.0 centimeters; power, 13. The angle between lines of collimation of telescope and the collimator may be read by small circle to single degrees.

3. *Steinheil's Spectroscope*. The clear aperture of train, including two 60° prisms, is 4.0 centimeters. Focal length of collimator and telescope 32.5 centimeters, powers, 8, 12, *etc.* Photographic scale.

4. *Silbermann's Heliostat*, etc. This instrument by Duboscq, has two mirrors, 18.0 centimeters by 9.0 centimeters, one silver under glass and the other silver. Also, *porte-lumière*.

5. *Heliostat*, with perfect plane mirror 16.8 c. m. diameter. Designed by Rowland and made by Schneider.

6. *Jamin's Interferential Refractometer*, with tubes 100 centimeters long, for the study of refraction in gases and a glass trough 20 centimeters long for liquids, by Duboscq.

7. Complete apparatus for the study of phenomena of interference, by Duboscq.

8. *Photographic Apparatus*. Objective 6.1 centimeters aperture, and about 40 centimeters focal length for plates; 10 × 12 inches, by Steinheil. Dark room, collection of chemicals and everything necessary for experiments on this subject.

9. *Becquerel's Phosphoroscope*, by Duboscq.

10. *Polarizing Apparatus*, by Steeg; also by Duboscq.

11. Apparatus for producing monochromatic light of any color. Designed by Hastings and made by Schneider.

12. *Prisms, gratings*, etc.

a. Hollow prism by Meyerstein; aperture, 6.1 × 5.2 centimeters.

b. Hollow prism by Steinheil; aperture, 2.2 centimeters.

c. Thallium glass prism by Steinheil; aperture, 4.8 centimeters.

d. Two flint glass prisms by Steinheil; aperture, 4.7 centimeters.

e. Crown glass prisms by Steinheil; aperture, 4.8 centimeters.

f. Two quartz prisms by Steeg; faces, 3.4 × 3.0 centimeters.

g. Iceland spar prism; faces, 2.6 × 2.2 centimeters, by Steeg.

h. Two rocksalt prisms; faces, 5.0 × 4.0 centimeters, by Steeg. Also rocksalt lens.

i. Large Nicol prism, largest diagonal 6.5 centimeters. Also a number of smaller ones.

j. Gratings on speculum metal 4.3 × 3.9 centimeters with 8648 lines to the inch, and 4.4 × 4.4 centimeters with 17,396 lines to the inch, and a smaller glass grating with 8648 lines to the inch, all by *Chapman with* Rutherfurd's engine.

Kirchoff's, Angstrom's, and Rutherfurd's maps of the solar spectrum.

k. Old telescope by Dollond. Objective about 4 in. diameter and 6 ft. focal length.

ELECTRICITY AND MAGNETISM.

The distinguishing feature of the apparatus for these subjects is its accuracy and the determination of the constants in absolute measure. The collection is *unique* in this respect.

13. *Rowland's Absolute Electrometer* for potentials represented by sparks of about 0.1 to 1 inch. Designed on Sir Wm. Thomson's guard-ring principle and constructed by Edelmann of Munich. Guard-ring 33.5 centimeters diameter, and can be separated about 7 centimeters, the distance being read by vernier to 0.01 centimeter. Movable disc 10 centimeters diameter, and *firmly* attached to arm of a balance sensitive to 1 mgr. Balance moves only .01 centimeter, and means of two distances of the discs are taken, the one to move it to upper and the other to lower stop. Weights of from 1 to 5 grammes ordinarily used. *Discs ground and polished to mirror surface after nickel plating.*

14. *Rowland's Electrostatic Standard Condenser*. Constructed by Grunow of New York. One sphere within the other *nickel plated and ground to mirror surface*, with extra ball for interior. Balls, 7 and 8 inches diameter. Hollow sphere, 10 inches diameter. Apparatus for centering. Radii determined by loss of weight in water. Can be charged and discharged any number of times at the rate of three per second, by means of fine wires which pass in momentarily from outside and thus do not change the capacity greatly. Any condenser can be compared with it by means of an electrometer.

15. *Thomson's Quadrant Electrometer*, by White of Glasgow, with Thomson's key.

16. *Condenser* ⅓ microfarad by Elliott.

17. *Commutators* for high (say 1 inch spark) as well as low tension.

18. *Rowland's Galvanometer* for the absolute measurement of discharges of high tension. Constructed by Rowland and Schneider. Coils wound with paper between, and boiled in parafin *in vacuo* at 100° C. to be thoroughly dry. Needle shielded from electrostatic action, and deflection read by mirror and scale. Number of coils about 11,000. Constant on the cm. gr. second system 19,091. = G of Maxwell as determined by comparison with galvanometer described in American Journal of Science, vol. xv, p. 334. See No. 19 below.

19. *Rowland's absolute Galvanometer* for the measure of quite weak currents. Constant 1833.2. See American Journal of Science, vol. xv., p. 334. Constant very accurately known. 1790 turns. Can be used as sine galvanometer or with mirror and scale. Horizontal circle reads to 1′, but is readily estimated to 30″. Telescope and bar for determining horizontal intensity in exact position of instrument.

20. *Rowland's Tangent Galvanometer*, brass circle 50 centimeters diameter. Circle graduated to 15′ and 20 centimeters diameter. From 1 to 243 turns can be used, the constant of each set being known with great accuracy. Made by Meyerstein, but altered and wound and coils measured by Rowland.

21. *Two Thomson's Galvanometers* of high and low resistance, the first differential with coils around both needles and set of shunts, by Elliott of London.

22. *Two Nobili Astatic Galvanometers* by Elliott, and one by Salleron.

23. *Wiedemann Galvanometers* with two sets of coils and two kinds of needles. Reading by mirror and scale.

24. *Galvanometer* with large wire for experiments on the damping effect of the coils on the needle, and for determining resistance in absolute measure. Designed by Rowland and made by Schneider.

25. *Tangent Galvanometer*, wooden circle, with variety of coils of known constant.

26. *Mirror Galvanometer.*

27. *Rowland's wooden circle*, 84 centimeters diameter, carefully laid up out of maple wood, and containing several grooves on the edge to contain single wires. It is used to surround a galvanometer, when, by the aid of the electrodynamometer, the horizontal intensity can be measured at any instant. Extremely useful.

28. *Electrodynamometer* of form given in Maxwell's Electricity, vol. ii, p. 330. Outer circles about 27.5 centimeters diameter with 240 windings on each side. Constant, G, of outer coils 78,371 on cm. gm. second system. Inner coils about 5.5 centimeters diameter with 63 coils in each. Moment of inertia of suspended coil accurately known. Constant calculated and also determined by comparison with a tangent galvanometer made of the circle described above. Made (partly) by Gurley of Troy, and circles wound and measured by Rowland.

29. *Electrodynamometer*, Quincke's form for weak currents, by Edelmann of Munich.

30. *Standards of Resistance* mounted so that they can be placed in water. 1 and 10 ohms by Elliott; 10, 100, and 1,000 ohms by Warden, Muirhead, and Clark of London; also mounted in another style 1, 10 and 100 Siemens' units, by Siemens and Halske of Berlin. Also three copies of coil whose absolute resistance was determined by Rowland as 34.719 *earthquad ÷ sec.*

31. *Resistance coils* in boxes 1 to 10,000 and 10,000 to 100,000 ohms by Elliott, and 1 to 10,000 Siemens' units by Edelmann.

32. *Rowland's Resistance Comparator.* Ten coils of 10 ohms each, arranged so that they can be joined in series or abreast, thus making 1, 10, and 100 ohms besides intermediate ones. Made by Schneider and adjusted by Rowland.

33. *Two bridges* of Jenkins' form for the accurate comparison of equal resistances, and also a Wheatstone bridge, having a wire of platinum-iridium alloy one meter long, by Elliott.

34. *Magneto-electric Machine* for 1,200 candles, by Siemens Brothers, London, with engine to drive it, and both Siemens' and Foucault's lamps. Also battery of 60 large bichromate cells.

35. *Ruhmkorff coil*, spark 15 or 20 centimeters, by Ruhmkorff of Paris.

36. *Rowland's Earth inductor* with *brass* circle. 30 centimeters diameter, wound and measured by Rowland. Made by Meyerstein of Göttingen.

37. *Ruhmkorff's Apparatus* for diamagnetism, by Ruhmkorff of Paris.

38. *Electric Clocks* beating seconds from regulator.

39. *Rowland's Standard of Electromagnetic Induction.* Three coils on brass cylinders which can be placed accurately on top of each other. See American Journal of Science, vol. xv. Mutual potential of coils with unit current 3775500., 2561974., 2051320., *etc.*, on the cm. grm. second system.

40. *Telescopes, Scales, and Mirrors.* Silvered brass millimeter scale by Brown and Sharp. Mounted telescope by Steinheil, objective 4.0 centimeters diameter, with three oculars, giving powers of 20, 40, and 80. Unmounted telescope by Steinheil, objective 2.7 centimeters diameters, and 3 oculars.

Mounted telescope and paper scale by Meyerstein: objective, 2.7 centimeters diameter.

41. Thin mirrors and plain parallel glasses by Steinheil. The mirrors gave a *perfect image with the highest magnifying power.*

Thomson's Replenisher on large scale for use with electrometer, Holtz and friction machines, Leyden jar batteries, Geissler tubes, &c.

HEAT.

42. *Rowland's Instrument for comparing the mercurial with the air Thermometer* between 0 and 100° C. Constructed by Schneider. Readings seldom differ more than 0.02° or 0.03° C. at any one point, especially up to 40° C., and a change is contemplated which will improve it.

43. *Rowland's Instrument for comparing Thermometers* from 0° to about 300° C. Constructed by Schneider. Accurate to about 0.1° C.

44. *Regnault's Air Thermometer*, by Golaz, Paris.

45. *Jolly's Air Thermometer*, by Berberich, Praeparator, Phys. Inst., Univ. of Munich.

46. *Regnault's Apparatus for Expansion of Gases* both at constant pressure and constant volume, also Regnault's form of Rudberg's apparatus, by Golaz, Paris.

47. *Regnault's Apparatus for Tension of Vapors*, including: *a.* the boiler; *b.* the reservoir for compressed air; *c.* a rotary pump for compressing gases; *d.* mercurial manometer, by Golaz, Paris.

48. *Regnault's Apparatus for specific Heat* of solids, by Golaz, Paris.

49. *Regnault's Hygrometer with Aspirator*, by Golaz, Paris.

50. *Thermometers*, about 30 or 40, principally by Baudin, Paris, and Geissler, Bonn. Many of these have been compared with the air thermometer as well as with standards by Fastré, Casella, or from Kew. The thermometers up to 40° C. undoubtedly represent the air thermometer more accurately than any so far constructed, and are supposed to agree with it to about 0.01° C. They have been compared with it eight times during about one year or more. The error in calorimetric investigations from using uncompared thermometers *may* amount to two per cent.

51. *Rowland's Apparatus for determining Change of specific Heat of Liquids* with temperature, by Schneider.

52. *Dulong's Apparatus for the Heat of Combustion*, by Salleron, Paris.

53. *Melloni's Apparatus* for radiant energy, by Salleron, Paris.

54. *Two Instruments for the Calibration* of mercurial thermometers, one by Golaz and the other by Salleron.

55. *Rowland's Apparatus for determining the mechanical Equivalent of Heat*, or for investigating the specific heat of liquids and their change with rise of temperature.

This instrument was constructed by the aid of funds contributed by the Rumford committee of the American Academy of Arts and Sciences, but the instrument will remain for the present at Baltimore. It was constructed by Schneider. It is run by a petroleum engine, No. 67 below.

⁂ To be constructed soon:—

Apparatus for compressing gases to 1000 atmospheres.

Apparatus for *accurately* determining the form of the adiabatic curve of gases and vapors *at any temperature up to about* 100° C.

MISCELLANEOUS.

56. *Comparator*, by Meyerstein, for bars 1 meter long. Microscopes cannot be set nearer than 10 centimeters. One division of head of micrometer screws is about $\frac{1}{700}$ millimeter.

57. *Microscope Comparator*, designed by Rowland after Rogers' plan and made by Grunow.

58. *Dividing Engine*, by Perreaux. Free motion about 55 centimeters Screw $\frac{1}{2}$ millimeter thread. Head divided into 250 parts. 501 divisions of head give 1 millimeter almost exactly. Subsidiary screw at right-angles to the other.

59. *Air Pumps.* Rotary and common, by Ritchie, of Boston; mercury, on Jolly's plan, by Berberich, of Munich.

60. *Rotary Pump* for compressing gases to 15 atmospheres, by Golaz, Paris.

61. *Three Mercury Gauges;* one about 25 meters high, and measuring pressures up to about 33 atmospheres; one movable and measuring pressure from 1 to 4 atmospheres; and one measuring from 0 to 1 atmosphere.

62. *Barometer*, by James Green of New York, with very large tube.

63. *Two Cathetometers*, one by Meyerstein, and the other by Salleron.

64. *Standard Meters*, compared at Washington.

65. *Balances and Weights.* One balance weighing to 5 kilo. and accurate to about 1 mg. with weights from 5 kilo. to 1 mg. One weighing to 200 grms. accurate to about 0.1 mg. with weights from 100 gr. to 1 mg. These are by Schickert of Dresden. One heavy balance weighing to about 25 kilo. and accurate to about 0.1 grm. by Schneider.

Standard glass kilogramme on Jolly's plan, and compared with Berlin standard, by Berberich of Munich.

The first balance mentioned is mounted on top of a case, so that globes for weighing gases can be suspended beneath it.

66. *Clock-work* with Foucault's regulator for running small apparatus at a regular velocity.

67. *Petroleum Engine* of three-horse power. It is capable of giving a large amount of compressed air at more than 100 pounds to the square inch pressure, and might be used for repeating Thomson's and Joule's experiments, or any others on the flow of gases.

68 *Two Spherometers*, large by Meyerstein, and small by Salleron.

69. Several extra micrometer eye-pieces.

70. *Apparatus for Researches on the Flow of Liquids.* Greatest available head about 1.4 meters.

71. *Revolving mirror* capable of 250 revolutions per second. Mirror of glass silvered on both sides and 4.7 cm. diameter. Driving power, compressed air from a Root blower. Designed by Rowland and made by Schneider.

72. *Metallic Manometer* for very minute differences of pressure, by Edelmann of Munich.

⁂ Nos. 19, 25, 26, and 28, and the silvered scale of No. 40 belong to Professor Rowland, but are used in the laboratory.

LIST OF PERIODICALS.

The following list contains an enumeration of the principal periodicals, devoted either wholly or partially to the discussion of mathematical and physical subjects, which are taken by the Library of the Johns Hopkins University, and the Library of the Peabody Institute.

The publications of learned societies are usually given under the name of the place where the meetings are held. The University Library is designated by H. The Peabody Library is designated by P. A complete set is thus indicated P*, etc.

American acad. of arts and sciences: Memoirs. Proceedings. Boston.	P.*
American assoc'n for the advancement of sci.: Proceedings. Salem.	H. P.*
American ephemeris and nautical almanac. Washington.	H. P.
American journal of mathematics. Baltimore.	H.* P *
American journal of science and arts. New Haven.	H.* P.*
Analyst. Des Moines.	H.
Annalen der physik und chemie. (Poggendorff.) Leipzig.	H.* P.*
Annales de chimie et de physique. Paris.	H. P.*
Annales de l'observatoire de Paris: Mémoires. Observations.	P.*
Annales des mines. Paris.	P.*
Annales des ponts et chaussées. Paris.	P.*
Annales du conservatoire des arts et métiers. Paris.	P.*
Annali di matematica. (Brioschi.) Milan.	H.
Annuaire du bureau des longitudes. Paris.	P.*
Annual record of science and industry. New York.	H. P.*
Archiv der mathematik und physik. (Grunert.) Leipzig.	H. P.*
Archives des sciences physiques et naturelles. Geneva.	P.*
Astronomische nachrichten. Kiel.	H. P.
Bollettino di bibliogr. e storia delle scienze matemat. e fisiche. Rome.	H.*
Berlin. Königliche akad. der wissensch.: Physikal. Abhdl.	P*
Mathemat. Abhdl.	H. P.*
Monatsberichte.	H.
British assoc'n for the advancement of sci.: Proceedings. London.	H * P.*
Reports. London.	H.* P.*
Brussels. Académie des sciences de Belgique: Annuaire. Bulletins.	P.*
Mémoires couronnés des savants étrangers.	P.*
Mémoires et nouveaux mémoires.	P.*
Buffalo. Academy of science: Bulletin.	P.*
Bulletin de la société mathématique de France. Paris.	H.
Bulletin des sciences mathématiques et de l'astronomie. Paris.	H.
Cambridge (Mass.) Annals of Harv. coll. observatory.	H.
Cambridge (England). Philosophical society. Proceedings.	H.
Transactions.	H. P.*
Cherbourg. Société nationale des sciences naturelles et mathématiques: Mémoires.	H.
Chicago. Academy of sciences: Transactions.	P.
Comptes rendus des séances de l'académie des sciences. Paris.	H. P.*
Connecticut academy of arts and sciences: Transactions.	H. P.*
Dingler's polytechnisches journal. Augsburg.	H. P.*
Dublin: Royal Irish academy: Transactions.	P.*
Edinburgh. Royal society: Transactions	P.*
Educational times. London.	H.
Engineer. London.	P.
Engineering. London.	P.*
Engineering and mining journal. New York.	H. P*
Fortschritte der Physik. Berlin.	H.
Franklin Institute: Journal. Philadelphia.	H. P.*
Giornale di matematiche. Naples.	H.
Göttingen. Königliche gesellschaft der wissenchaften: Nachrichten.	H. P.*
Göttingische gelehrte anzeigen.	H. P.*
Great Britain and Ireland: Government publications.	P.
Institut de France: Académie des sciences: Comptes rendus.	P.*
Mémoires. Mémoires présentés par divers savants.	P.*
Sciences mathématiques et physiques.	P *
Institution of civil engineers: Minutes. London.	P.*
Irish academy (royal): Transactions. Dublin.	P.*
Jahrbuch über die fortschritte der mathematik. Berlin.	H.
Jahresbericht über die chemie und physik. Giessen.	H.
Journal de l'école polytechnique. Paris.	H. P.*
Journal de mathématiques pures et appliquées. Paris.	H. P.*
rnal de physique théorique et appliquée. Paris.	H.
Journal für d. reine und angewandte mathematik. (Crelle.) Berlin.	H. P.*
Leipzig. Astronomische gessellschaft: Vierteljahrsschrift.	H.
Liége: Société royale des sciences: Mémoires.	P.*
London. Institution of civil engineers: Minutes.	P.*
Mathematical society: Proceedings.	H.*
Royal astronomical society: Memoirs.	P.*
Monthly notices. Proceedings.	H. P.*
Royal society: Philosophical transactions.	H. P.*
Proceedings.	H. P.*
London, Edinburgh and Dublin philosophical magazine. London.	H. P.*
Mathematische annalen (Clebsch.) Leipzig.	H. P.*
Messenger of mathematics. London.	H.
Munich. Königliche akademie der wissenschaften:	
Abhandlungen der mathemat. physik. classe.	P.*
Sitzungsberichte der mathemat. physik. classe.	P.*
Nature. London.	H. P.*
Nautical almanac. (London.)	H. P.
Nautical almanac. (Washington.)	H. P.
Nouvelle correspondance mathématique. Liége.	H.
Paris. Bureau des longitudes: Annuaire.	P.*
Conservatoire des arts et métiers: Annales.	P.*
École polytechnique: Journal.	H. P.*
Observatoire: Mémoires. Observations.	P.*
Société mathematique: Bulletin.	H.
See Institut de France.	P.*
Philadelphia. Franklin Institute: Journal.	H. P.*
Amer. philosophical society; Proc. and Trans.	H. P.*
Philosophical transactions. London.	H.* P.*
Polytechnisches journal. (Dingler.) Augsburg.	H. P.*
Popular science monthly. New York.	H. P.*
Quarterly journal of pure and applied mathematics. London.	H. P.*
Quarterly journal of science London.	H. P.*
Radcliffe observatory. Astronomical observations. Oxford.	P.*
Rendiconti del reale instituto Lombardo di scienze e lettere. Milano.	P.*
Repertorium d. rein. u. angewandt. mathematik. Leipzig.	H.
Repertorium für experimental-physik. München.	H.
Revue des cours scientifiques. Paris.	H.
Rome. Atti della reale accad. dei Lincei: Transunti. Memorie.	H.
Royal society: Philosophical transactions. London.	H. P.*
Proceedings. London.	H. P.*
Scientific american. New York.	H. P.
St. Louis. Academy of sciences: Transactions.	P.*
St. Petersburg. Académie impériale des sciences:	
Bulletin de la classe physico-mathém.	P.*
Bulletin scientifique.	P.*
Mélanges mathématiques.	P.*
Mélanges physiques et chimiques.	P.*
Mémoires: Sciences math. phys. et natur.	P.
Mémoires présentés par divers savants.	P.
Technologiste, Le. Paris.	P.*
Telegraphic journal and electrical review. London.	H.
United States: Government publications.	H. P.*
Van Nostrand's engineering magazine. New York.	H.
Vienna. K. K. akademie der wissenschaften:	
Denkschriften: Mathemat.-naturwissen. classe.	P.*
Sitzungsberichte: Mathemat.-naturwissen. classe.	H. P.*
Vierteljahrsschrift der astronomischen gesellschaft. Leipzig.	H.
Washington. Smithsonian institution: Contributions.	
Miscellaneous collections. Annual reports.	H.* P.*
Zeitschrift für angewandte elektricitätslehre. München.	H.*
Zeitschrift für mathematik und physik (Schlömilch). Leipzig.	H. P.*

LIST OF MATHEMATICAL AND PHYSICAL PAPERS,

Published by Members of the University, September, 1876, to February, 1880.

BY PROFESSOR SYLVESTER.

In the American Journal of Mathematics, (1878–80.)

Application of the New Atomic Theory to the Graphical Representation of the Invariants and Covariants of Binary Quantics.

On Differentiants Expressed in Terms of the Differences of the Roots of their Parent Quantics.

Note on M. Hermite's Law of Reciprocity.

Completion of the Theory of Principal Forms.

Additional Illustrations of the Law of Reciprocity.

On the Principal Forms of the General Sextinvariant to a Quartic and Quartinvariant to a Sextic.

On the Probable Relation of the Skew Invariants of Binary Quintics and Sextics to one another, and to the Skew Invariant of the same Weight of the Binary Nonics.

On Clebsch's *Einfachstes System associirter Formen* and its Generalization.

Note on the Ladenburg Carbon-graph.

Note on the Theorem contained in Prof. Lipschitz's Paper entitled "Demonstration of a Fundamental Theorem obtained by Mr. Sylvester" in Am. Jour Math., I, pages 336-341.

A Synoptical Table of the Irreducible Invariants and Covariants to a Binary Quintic, with a Scholium on a Theorem in Conditional Hyperdeterminants

Notes on Determinants and Duadic Disynthemes Two papers.

On the Complete System of the *Grundformen* of the Binary Quantic of the Ninth Order.

Tables of the Generating Functions and Groundforms for the Binary Quantics of the First Ten Orders.

On the Resolution of Numbers into the Sum or Difference of two Cubes.

Tables of the Fundamental Covariants of a System of two Binary Quantics for all Combinations of Orders not exceeding Four, and Observations on the preceding.

On the Divisors of Cyclotomic Functions.

In the Proceedings of the Royal Society, London.

On the Limits to the Order and Degree of the Fundamental Invariants of Binary Quantics. (1878.)

In the Messenger of Mathematics, London.

Rule for Abbreviating the Calculation of the Number of In- or Co-Variants of a given Order and Weight in the Coefficients of a Binary Quantic of a given Degree. (1878).

Note on Continuants. (1878).

On a Theorem connected with Newton's Rule for the Discovery of the Imaginary Roots of Equations. (1879).

On the Strict Relation between Discriminants and Remittants, and the Product of Differences of Roots of Binary Forms. (1880).

In the London, Edinburgh and Dublin Philosophical Magazine, London.

Two papers on Spherical Harmonics, containing the New Theory of the Bipotential. (1876).

On a Generalization of Taylor's Theorem. (1877).

Proof of the Hitherto Undemonstrated Fundamental Theorem of Invariants. (1878).

Note on an Equation of Finite Differences. (1879).

In the Educational Times, London.

Mathematical Questions for Solution, of an original character and embodying distinct theories, monthly during the years 1876-79, in continuance of a series, begun many years ago.

Joural für reine und angewandte Mathematik, (Crelle.) Berlin

Sur les actions mutuelles des formes invariantives dérivées. (1878).

Sur les déterminants composés. (1879).

Sur un déterminant symétrique qui comprend comme cas particulier la première partie de l'équation séculaire. (1879).

Note sur une propriété des équations dont toutes les racines sont réelles. (1879).

Sur l'entrelacement d'une fonction par rapport à une autre. (1879).

Preuve instantanée d'après la méthode de Fourier, de la réalité des racines de l'équation séculaire (1879).

In the Comptes Rendus de l'Académie des Sciences de l'Institut de France.

Sur les invariants fondamentaux de la forme binaire du huitième ordre. (1877).

Sur une méthode algébrique pour obtenir l'ensemble des invariants et des covariants fondamentaux d'une forme binaire. (1877).

Sur une méthode algébrique pour obtenir l'ensemble des invariants et des covariants fondamentaux d'une forme binaire et d'une combinaison quelconque de formes binaires. (1877).

Sur le vrai nombre des covariants élémentaires d'un système de deux formes biquadratiques binaires (1877).

Théorie pour trouver le nombre des covariants et des contrevariants d'ordre et de dégré, donnés linéairement indépendants d'un système quelconque de formes simultanées, contenant un nombre quelconque de variables. (1877).

Sur les invariants. (3 papers.) (1877).

Sur la loi de réciprocité pour les invariants et covariants des quantics binaires. (1878).

Sur la théorie des formes associées de MM. Clebsch et Gordan. (1878).

Détermination d'une limite supérieure au nombre total des invariants et covariants irréductibles des formes binaires. (1878).

Sur les covariants fondamentaux d'un système cubo-quadratique binaire. (1878).

Sur le vrai nombre des formes irréductibles du système cubo-biquadratique. (1878).

Détermination du nombre exact des covariants irréductibles du système cubo-biquadratique binaire. (1878).

Sur les covariants irréductibles du quantic du septième ordre. (1878).

Sur la forme binaire du septième ordre (1878).

Sur la valeur moyenne des coefficients dans le développement d'un déterminant gauche ou symétrique d'un ordre infiniment grand, et sur les déterminants doublement gauches. (1879).

Table des nombres de dérivées invariantives d'ordre et de dégré donnés, appartenants à la forme binaire du dixième ordre. (1879).

Sur la valeur moyenne des coefficients numériques dans un déterminant gauche d'un ordre infiniment grand. (1879).

Sur une propriété arithmétique d'une certaine série des nombres entiers. (1879).

Sur le vrai nombre des covariants fondamentaux d'un système de deux cubiques binaires. (1879).

Sur les diviseurs des fonctions cyclotomiques. Two papers. (1880.)

BY DR. W. E. STORY.

In the American Journal of Mathematics.

On the Elastic Potential of Crystals. (1878.)

Note on the Paper of MR. KEMPE, entitled the "Geographical Problem of the Four Colors," in the Am. Jour. of Math., II, 3. (1879.)

BY DR. T. CRAIG.

Motion of a Point on the Surface of an Ellipsoid. (*Am. Jour. of Math.*, 1878).

The Motion of a Solid in a Fluid. (*Am. Jour. of Math.*, 1878).

Mathematical Theory of Fluid Motion (*Van Nostrand's Eng. Mag.*, 1879; *also printed in a volume, New York, Van Nostrand,* 1880).

General Differential Equation for Developable Surfaces. (*Jour. of Franklin Inst.*, 1879).

Projection of the General Locus of Space of Four Dimensions into Space of Three Dimensions. (*Am. Jour. of Math.*, 1879).

The Motion of an Ellipsoid in a Fluid. (*Am. Jour. of Math.*, 1879.)

On the Sphere which cuts Five given Spheres at the same Angle. (*Analyst*, 1880).

BY MR. F. FRANKLIN.

Bipunctual Coordinates. (*Am. Jour. of Math.*, 1878).

On a Problem of Isomerism. (*Am. Jour. of Math.*, 1878).

Notes on Partitions of Numbers, etc. (*Am. Jour. of* Math., 1878, 1879).

BY DR. G. B. HALSTED.

Bibliography of Hyper-Space and Non-Euclidean Geometry. (*Am. Jour. of Math.*, 1878).

Note on the First English Euclid. (*Am. Jour. of Math.*, 1878).

BY MISS CHRISTINE LADD.

Quaternions. (*Analyst*, 1877).

The Polynomial Theorem. (*Analyst*, 1878).

On some Properties of Four Circles Inscribed in One and Circumscribed about Another. (*Analyst*, 1878).

On Pascal's Hexagram. (*Am. Jour. of Math.*, 1879).

BY MR. W. I. STRINGHAM.

Some General Formulae for Integrals of Irrational Functions. (*Am. Jour. of Math.*, 1879).

The Quaternion Formulae for Quantification of Curves, Surfaces and Solids for Barycentres. (*Am. Jour. of Math.*, 1879).

BY PROFESSOR ROWLAND.

The Magnetic Effect of Electrical Convection. (*Am. Jour. of Science*, 1878; *abstract by Helmholtz in Monatsbericht d. Berlin. Akad.*.

Research on the Absolute Unit of Electrical Resistance. (*Am. Jour. of Science*, 1878).

Note on the Theory of Electrical Absorption. (*Am. Jour. of Math.*, 1878).

On Professor Ayrton and Perry's New Theory of the Earth's Magnetism, with a Note on a New Theory of the Aurora. (*Philos. Mag.*, 1879).

Note on the Magnetic Effect of Electrical Convection. (*Philos. Mag.*, 1879).

On the Diamagnetic Constants of Bismuth and Calc-Spar in Absolute Measure, part I. (*Am. Jour. of Science*, 1879).

On the Mechanical Equivalent of Heat, with Subsidiary Researches on the Variation of the Mercurial from the Air Thermometer, and on the Variation of the Specific Heat of Water. (*Amer. Acad.*, *Boston*, 1880; *also printed separately*, *Cambridge*, *J. Wilson & Son*, 126 *pp.*, 8*vo.*, *one plate.*)

BY DR. C. S. HASTINGS.

The Influence of Temperature on the Optical Constants of Glass. (*Am. Jour. of Science*, 1878).

On Lockyer's Hypothesis, that the so-called Elements are Compound Bodies. (*Am. Chem. Jour.*, 1879).

On the Perfect Color Correction in Triple Objectives. (*Am. Jour. of Science*, 1879).

BY MR. C. S. PEIRCE.

On the Ghosts in Rutherfurd's Diffraction Spectra. (*Am. Jour. of Math.*, 1880).

A Quincuncial Projection of the Sphere. (*Am. Jour. of Math.*, 1880).

BY DR. W. W. JACQUES.

Effect of the Motion of Air within an Auditorium upon its Acoustic Qualities. (*Jour. of Franklin Inst.*, 1878: *Philos. Mag.*, 1879).

Velocity of Very Loud Sounds. (*Am. Jour. of Science*, 1879; *Philos. Mag.*, 1879).

Diamagnetic Constants of Bismuth and Calc-Spar Crystals in Absolute Measure. (*Am. Jour. of Science*, 1879).

Distribution of Heat in the Spectra of Various Sources of Radiation. (*Am. Acad.*, *Boston*, 1879).

BY MR. E. H. HALL.

On a New Action of the Magnet on Electric Currents. (*Am. Jour. of Math.*, 1879).

BY DR. E. L. NICHOLS.

A New Explanation of the Colors of the Sky. (*Philos. Mag.*, 1879).

Character and Intensity of the Rays emitted by glowing Platinum. (*Am. Jour. of Science*, 1879).

Optical Method for the Measurement of High Temperatures. (*Am. Jour. of Science*, 1880).

NOTE.—The foregoing list does not include the papers of any writer published previously to his connection with this institution, or after he left it; and it omits light articles and those of a merely transient interest. It does not include the papers of non-resident lecturers.

The following note may be regarded as a Postscript to the Memoir by Professor Rowland on the Mechanical Equivalent of Heat, (Cambridge, 1880.) recently published in the Proceedings of the American Academy of Arts and Sciences in Boston.

NOTE FROM PROFESSOR ROWLAND.

[*Comparison with Dr. Joule's Thermometer.*]

Dr. Joule has kindly sent me the comparison of my thermometer, No. 6166, with his, and the result will be published in full in the "Proceedings of the American Academy of Sciences." In this manner I have been able to make the exact reduction of his results to the air thermometer. The following are the results:

DATE.	METHOD.	Temperature of water.	Joule's value of the equivalent.	Joule's value reduced to the air thermometer, and to the latitude of Baltimore. English System.	Metric System.	Rowland's value.	Difference.
1847	Friction of water...	15°.	781.5	787.0	442.8	427.4	+15.4
1850	" " " ..	14°.	772.7	778.0	426.8	427.7	— .9
"	" " mercury	9°.	772.8	779.2	427.5	428.8	— 1.3
"	" " "	9°.	775.4	781.4	428.7	428.8	— .1
"	" " iron	9°.	776.0	782.2	429.1	428.8	+ .3
"	" " "	9°.	773.9	780.2	428.0	428.8	— .8
1867	Electric heating...	18°.6			428 0	426.7	+ 1.3
1878	Friction of water...	14°.7	772.7	776.1	425.8	427.6	— 1 8
"	" " " ..	12°.7	774.6	778.5	427.1	428.0	— .9
"	" " " ..	15°.5	773.1	776.4	426.0	427.3	— 1.3
"	" " " ..	14°.5	767.0	770.5	422.7	427.5	— 4.8
"	" " " ..	17°.3	774.0	777.0	426.3	426.9	— .6

The mean difference of the two amounts to only 1 in 430, almost exactly the same as I estimated in the body of my paper, an extremely satisfactory result.

H. A. ROWLAND.

BALTIMORE, February 16th, 1880.

Brief Announcements.

DR. C. SIHLER, Assistant in the Biological Laboratory, will give, under the direction of the Professor of Biology, a course of eighteen practical lessons in the *Use of the Microscope*, and in *Microscopic Anatomy*. The lessons will begin Saturday, March 6, and will be given on Wednesdays and Saturdays of each week at 3 P. M., continuing for about one hour and a half each. The course is intended for medical students and physicians. Fee, ten dollars, to be paid at the Treasurer's office, in the University building.

MR. A. S. COOK, Associate in English, has formed a class for the study of *Elementary Anglo-Saxon*. It will meet on Tuesdays, Wednesdays and Fridays, at 4 P. M., in rooms A and B, No. 187 North Howard St., beginning February 10.

DR. H. B. ADAMS, Associate in History, has organized a class for the study of the *History and Elements of Political Economy*, which will meet on Mondays, Wednesdays, Thursdays and Fridays, at 4 P. M. in room 3, commencing February 9.

DR. MINTON WARREN, Associate in Latin, has formed classes for reading *Livy*, books xxi and xxii, and *Lucretius*, books i, iii and v. meeting four times a week, beginning Tuesday, February 17.

HENRY C. ADAMS, Ph. D., lately a Fellow of Johns Hopkins University, and now lecturer at Cornell University, will commence a course of instruction in *Political Economy*, at this University in the early spring.

MR. SYDNEY LANIER, Lecturer on English Literature, has formed a class for expository readings in *English Literature*.

DR. THOMAS CRAIG, Lecturer on Mathematics, will give a course of thirty lectures on the general *Theory of Functions of A Complex Variable, including Riemann's Theory*, on Tuesdays, Thursdays and Fridays, at 7 P. M., beginning Tuesday, February 24. The following works of reference are recommended: Briot et Bouquet—*Théorie des Fonctions Elliptiques*. Neumann—*Vorlesungen über Riemann's Theorie*. Durege—*Elemente der Theorie der Functionen*.

PHYSICAL LABORATORY: COMPARISON OF STANDARDS.

BALTIMORE, *February*, 1880.

In order to secure uniformity throughout the country in certain physical standards, and to facilitate the use of the absolute system of heat measurement, it has been thought advisable to organize in the physical department of this University a sub-department, where comparisons of standards can be made.

Comparison of Thermometers. At present we are only able to make comparisons of thermometers, and so to reduce their degrees to the absolute scale of the perfect gas thermometer.

As the work is very laborious, it is proposed to make this sub-department self-supporting, by a system of fees sufficient to cover the bare cost of the labor, so that all may avail themselves of the facilities here offered.

In a recent study of standard thermometers by Geissler, Baudin, Fastré, Casella and from Kew, and the comparison of the same with the air thermometer, the differences due to the variety of the glass amounted to 0°. 2 or 0°. 3 C., and the differences from the air thermometer were as high sometimes as 0°. 3 C. at the 40° point.

The error from using uncompared mercurial thermometers in calorimetric investigations may amount to one or two per cent. For this reason the air thermometer has been taken as the standard, and all comparisons will be reduced to the final absolute standard of the perfect gas thermometer.

Very complete studies of thermometers have been made between 0 and 40° C., and a less complete study between 0 and 100°, and between 100° and 250°. Up to 100°, our thermometers have not only been compared with the air thermometer, but also with standards by Fastré, Geissler, Casella, Baudin and from Kew.

The study from 0 to 40° has been published by the American Academy of Sciences, at Boston, in a memoir on the Mechanical Equivalent of Heat. One of our thermometers is also now in the hands of Dr. Joule, who has compared it with the original thermometers used by him in the determination of the Mechanical Equivalent of Heat.

The apparatus for the comparison up to 100° C., is described in the paper above referred to. The thermometers are totally immersed in the water with their stems very near the bulb of the air thermometers. From 100° up to 250° an oil bath is used, the bulbs only being in the oil, but the stems are heated to the same degree by being in contact with a heavy copper bar, whose temperature is noted by separate thermometers.

The ordinary comparison is made with the stems of the thermometers in a vertical position. Where they are used in a horizontal position a correction will have to be made, and this correction will be determined when it is so desired. When the comparison is made only to 40°, we can compare them in a horizontal position, but we cannot then insure the same accuracy as when they are vertical, and it is never advisable to use them in that position.

Where desired, a study will be made of the changes of the zero point as a function of the temperature to which it has been heated, and of the time, but this study is not advised, as it does not lead to very valuable results.

Thermometers with metal, wooden or paper scales, are generally too poor to be worth comparison, and would often be spoiled by the immersion in the water. Thermometers with metal caps of Geissler's form are often injured, especially when heated to 250° C. Therefore, comparisons of thermometers of these classes will not be undertaken, except in the case of standards long used for some particular purpose, or in that of fine Geissler thermometers.

Three intervals for the comparison have been selected.

A. Between 0 and 40° for thermometers used for meteorological observations, determination of the temperature of standards of length, calorimetric determinations, and all purposes where extreme accuracy is desired within that limit. To obtain the full value of such a comparison, thermometers should be graduated at least as fine as 0°. 1 C. or 0°. 2 F.

B. Between 0 and 100° C. It is advised that the thermometers sent be graduated at least as fine as 0°. 2 C. or 0°. 5 F.

C. Between 100° and 250° for thermometers used by chemists in the determination of melting or boiling points. Thermometers should be graduated to 1° C. or 1° F.

Three kinds of comparison will be made for each of the intervals 0 to 40°, 0 to 100°, and 100° to 250° as follows.

1st. Direct comparison with the air thermometer, and also a primary standard. This comparison is very laborious, and is not recommended except in very exceptional cases, as more than one comparison should be made to insure good results.

2nd. Comparison with primary standards which have been compared many times with the air thermometer. This is recommended where an error of $\frac{1}{100}^\circ$ is of some importance.

3rd. Comparison with secondary standards which have been compared many times with the primary standards, and not very often directly with the air thermometer. This is recommended in all ordinary cases, where an error of $\frac{2}{100}^\circ$ can be tolerated.

When several comparisons are made, the following intervals will be allowed between the experiments, so that the zero reading may be allowed to return to its primitive value.

Thermometers heated to 40° C. about 1 week.
" " " 100° C. " 6 weeks.
" " " 250° C. " 4 months.

The latter interval is too small for an accurate return.

For the exact details of the method of comparison, I must refer to the above mentioned paper on the Mechanical Equivalent of Heat.

It is advisable in all cases where great accuracy is desired, that a number of comparisons be made, seeing that delicate thermometers are constantly varying through slight limits, and the average state can only be determined by repeated experiments.

Reports. In the report of the comparison, the original readings will be given together with the reduced ones, and the plot of the curve of errors of the thermometer at every point. From this curve, the error of the thermometer at any reading can be found.

It is proposed to publish at the end of the year a complete report of all the comparisons made during the year, together with all new determinations of the errors of the standards, and to send it to any address at a price which we will hereafter announce.

Fees. The comparators allow five thermometers only to be placed in them, of which two are our own standards in ordinary comparisons, and one in direct comparisons with the air thermometer. Therefore, three thermometers can be compared as easily as one in ordinary cases, and four in direct comparisons. Hence the following system of fees has been made out.

A. *When a number of Thermometers are sent.*

Comparison between 0 and 40° C. for 3 or 4 thermometers.

Direct, probable error at each point,	= $\frac{1}{100}^\circ$	$30 00
Primary Standards " "	= $\frac{1}{100}^\circ$	11 00
Secondary " " "	= $\frac{2}{100}^\circ$	8 00

0 and 100° for 3 or 4 thermometers.

Direct, probable error at each point,	= $\frac{2}{100}^\circ$	$25 00
Primary Standards " "	= $\frac{2}{100}^\circ$	12 00
Secondary " " "	= $\frac{4}{100}^\circ$	9 00

100° to 250° for 3 or 4 thermometers.

Direct, probable error at each point,	= $\frac{1}{10}^\circ$	$20 00
Primary Standards " "	= $\frac{1}{10}^\circ$	12 00
Secondary " " "	= $\frac{1}{5}^\circ$	9 00

B. *For Single Thermometers.*

For single thermometers, the fees for the direct comparisons should be reduced to one-third, and for the ordinary ones to one-half the above figures. But in this case the thermometer will have to remain here until enough accumulate to fill the comparators.

Directions for Sending. With each thermometer, send the name of maker, the date when made, purpose for which it is used, and the highest temperature to which it has lately been heated, and the date of such heating, together with the kind of comparison desired, and whether the thermometer is generally used in the horizontal or the vertical position.

In packing, the thermometer should be placed in a small box, which should again be packed with straw in a larger box.

The thermometers, both during transit and while here, must be at the owners' risk. Only sufficient fees have been charged to cover the bare cost of the comparison, and we bear the risk of our own standards, which are probably more valuable than any of those which will be sent to us. But every care will be taken, and the probability of an accident is very small.

We expect soon to be able to make other comparisons, and notice will then be given of the fact by the issue of another circular.

H. A. ROWLAND,
Professor of Physics.

HOPKINS HALL LECTURES AND READINGS AT 5 P. M.

The following courses of lectures and readings, to be given in Hopkins Hall, at 5 P. M., will be open to the public subject to the regulations as to tickets, etc., heretofo announced.

History, by DR. H. B. ADAMS, Associate in History. Ten lectures on the ***Italian Renaissance and the Beginnings of Modern History.***

Dates and Special Topics.

1. *Tuesday, February* 10. The Unity and Transitions of History.
2. *Tuesday, February* 17. Venice and the Beginnings of Modern Commerce.
3. *Tuesday, February* 24. Papal Rome and the States of the Church.
4. *Tuesday, March* 2. The Renaissance of Pagan Rome.
5. *Tuesday, March* 9. Florence and the Beginnings of Modern Politics. The Medici. Savonarola.
6. *Tuesday, March* 16. The Beginnings of Modern Literature. Dante.
7. *Thursday, March* 18. Petrarch, Boccaccio, and Chaucer.
8. *Tuesday, March* 23. The Beginnings of Modern Art.
9. *Thursday, March* 25. The Revival of Learning and the Discoveries of Science.
10. *Tuesday, March* 30. The Renaissance of Geography and the Discovery of the New World.

The Vedas, by Dr. C. R. LANMAN, Associate in Sanskrit. Six lectures on the ***Ancient Literature of India.***

Dates and Special Topics.

1. *Monday, February* 16. India. Its peoples. The periods of its history. Our kinship with the Aryans.
2. *Thursday, February* 19. The grand divisions of the literature. First period. The Vedic literature. (*a*) Sanhita. (*b*) Brahmana. (*c*) Sutra

   Second period. The Sanskrit literature. Epic. Dramatic. Didactic. Scientific. Juristic. Buddhistic.
3. *Thursday, February* 26. The Sanhitas or Vedic Scriptures proper. Rig-veda Atharva-veda. Yajur-veda. Sama-veda. The Rig-veda. Its character, form, extent, date, origin, tradition, and relative importance.
4. *Thursday, March* 4. The home and civilization of the Vedic Aryans. The Vedic divinities, mythology, and folk-lore.
5. *Thursday, March* 11. The Vedic Religion. The Gods of the Light.
6. *Friday, March* 19. The Vedic Religion. The Gods of the Earth and Sky. The Vedic cosmogony. The doctrine of a future life.

History of Philosophy, by Professor G. S. MORRIS, of the University of Michigan. Eleven lectures on ***British Thought and Thinkers.***

Dates and Special Topics.

1. *Monday, February* 23. The General Characteristics of the English Mind.
2. *Monday, March* 1. Mediaeval Anticipations of Modern English Thought. (John Scotus Erigena, John of Salisbury, Roger Bacon, John Duns Scotus, William of Occam.)
3. *Monday, March* 8. Englishmen of the Renaissance. (Edmund Spenser, Sir John Davies, Richard Hooker.)
4. *Monday, March* 15. William Shakespeare.
5. *Monday, March* 22. Francis Bacon.
6. *Monday, March* 29. Thomas Hobbes.
7. *Monday, April* 5. John Locke.
8. *Monday, April* 12. George Berkeley.
9. *Monday, April* 19. David Hume.
10. *Monday, April* 26. Sir William Hamilton.
11. *Monday, May* 3. John Stuart Mill.

Greek, by PROFESSOR GILDERSLEEVE, Professor of Greek. Twelv lectures and readings in the ***Greek Tragic Poets.***

Dates and Special Topics.

1. *Wednesday, February* 18. Introductory: The beginnings tragic art.
2. *Wednesday, February* 25. Aeschylus: Life and art,—wi readings.
3. *Wednesday, March* 3. The Oresteia.
4. *Wednesday, March* 10. Macbeth and Agamemnon.
5. *Wednesday, March* 17. Sophocles.
6. *Wednesday, March* 24. Readings in Antigone and Electra.
7. *Wednesday, March* 31. Readings in Oedipus Rex and Oe pus Coloneus.
8. *Wednesday, April* 7. Readings in Ajax and Philoctetes.
9. *Wednesday, April* 14. Euripides.
10. *Wednesday, April* 21. Illustrative Readings in Euripides.
11. *Wednesday, April* 28. Illustrative Readings in Euripides.
12. *Wednesday, May* 5. On some characters common to the thr tragic poets.

French, by PROFESSOR RABILLON, Lecturer on French Literatu Twelve readings in ***French Literature.*** (*In French*).

Dates and Special Topics.

1. *Saturday, February* 21. Corneille: *Le Cid.*
2. *Saturday, February* 28. Corneille: *Le Cid.*
3. *Saturday, March* 6. Corneille: *Le Cid.*
4. *Saturday, March* 13. Racine: *Iphigénie.*
5. *Saturday, March* 20. Racine: *Iphigénie.*
6. *Saturday, March* 27. Racine: *Iphigénie.*
7. *Saturday, April* 3. Voltaire: *Zaïre.*
8. *Saturday, April* 10. Voltaire: *Zaïre.*
9. *Saturday, April* 17. Voltaire: *Zaïre.*
10. *Saturday, April* 24. Molière.
11. *Saturday, May* 1. Molière.
12. *Saturday, May* 8. La Fontaine.

The design of these readings is not only to explain those passages in the wo read, which may present difficulties, and to state the changes undergone by t language, but also to point out the literary beauties which might escape t notice of a reader.

☞ Those who propose to follow these readings are expected to bring wi them the text of the authors named.

History, by DR. AUSTIN SCOTT. Ten lectures on the ***Methods Historical Inquiry,*** beginning Tuesday, April 6.

Schedule of Dates of Current Courses.

Mondays, ...	PROF. G. S. MORRI
Tuesdays, (with two exceptions) . . .	DR. H. B. ADAM
Wednesdays, ...	PROF. B. L. GILDERSLEEV
Thursdays, (with one exception) . . .	DR. C. R. LANMA
Saturdays, ...	PROF. L. RABILLO

MEETINGS OF UNIVERSITY SOCIETIES.

Scientific Association.

January 7, 1880.

(1) MR. W. I. STRINGHAM presented a paper on Geometrical Figures in Space of Four Dimensions.

A regular figure in space of four dimensions is defined as one which is completely bounded by equal regular figures of three dimensions and whose vertices lie on the four-fold sphere. Three of such figures are, (1) the *Four-fold Pentoid*, bounded by five tetrahedra, (2) the *Four-fold Octoid*, bounded by eight cubes, (3) the *Four-fold Hexadekoid*, bounded by sixteen tetrahedra.

If $V =$ vertices (zero-dimensional), $E =$ edges (one-dimensional), $F =$ faces (two-dimensional), $S =$ solids (three-dimensional), then the numbers of vertices, edges, faces and solids which make up the above three figures are

$$(1),\ V = 5,\ E = 10,\ F = 10,\ S = 5;$$
$$(2),\ V = 16,\ E = 32,\ F = 24,\ S = 8;$$
$$(3),\ V = 8,\ E = 24,\ F = 32,\ S = 16.$$

By an interchange of V with S and E with F, (2) becomes (3) and *vice versa*, and hence (2) and (3) are called reciprocals of each other. Hence also (1) is self-reciprocal. The reciprocal of a regular figure is itself a regular figure; hence, except in the case of self-reciprocals, regular figures occur in pairs.

The figures (1), (2), (3) give the relation, $E + S = F + V$, which becomes Euler's equation for figures in space of three dimensions on substituting $S = 2$, which is the right value for this case, the polyhedron counting as *one* and the space which surrounds it as *one*. It can be proven that this formula is true for all four-fold figures.

The number of regular figures in four-dimensional space is finite, for the number of three dimensional figures by which they can be bounded is only five, and in order to form a four-dimensional angle by combining three dimensional figures about a given point, these figures must fall short of filling space of three dimensions and must therefore be finite in number.

The figure formed by taking as vertices the middle points of the edges of the Four-fold Pentoid, is a *Four-fold Dekoid*, bounded by five tetrahedra and five octahedra, and satisfies the relations $V = 10, E = 30, F = 30, S = 10$, whence as before $E + S = F + V$.

This paper was discussed by PROF. REMSEN, MR. E. H. HALL, and DR. E. L. NICHOLS.

(2) MR. L. B. FLETCHER gave an account of a peculiar Molecular Change in Iron at Red Heat.

An iron wire heated to whiteness, and allowed to cool gradually, contracts until a dull red heat is reached, when a sudden expansion takes place, followed by a gradual contraction as the wire cools to still lower temperatures. At the instant of this momentary expansion the wire is seen to glow suddenly and brilliantly. At about the same temperature a sudden and momentary contraction is observed during the heating of the wire.

It was thought that these changes might be ordinary thermal effects associated with some change in the superficial oxidation. To decide this point, Mr. Fletcher heated wires of iron and steel, and allowed them to cool in atmospheres of air, carbon dioxide, and coal-gas, as well as in a vacuum of a fraction of a millimetre, the effect observed in each case being the same. The cause of the phenomena must therefore be a molecular change occurring throughout the mass of the metal.

This was followed by remarks by PROFESSOR ROWLAND, on the phenomenon referred to in the last paper.

The phenomenon considered seems to be analogous with that of the retardation of the solidification of water. Water in a clear glass tube can be cooled below zero, and then suddenly solidifies with an expansion of volume.

(3) DR. C. SIHLER presented a communication On the Histological Changes in Developing Bone as a Prototype of Abnormal Growths.

The view was brought forward, that in growing bone, it is always the young and undifferentiated tissue which is the producer of the final tissues, and which invades and removes the old tissues; while the old tissues have not the power of giving rise to new ones.

This paper was discussed by DR. BARTON.

January 19, 1880.

A special meeting of the Association was held, to listen to a communication from DR. EMIL BESSELS, late Naturalist of the Polaris Expedition, and now of the Smithsonian Institution, on "Arctic Explorations."

Dr. Bessels narrated the history of explorations in the Arctic Circle, and discussed the best method of conducting them. He approved of the plan, suggested by the recent congress of geographers at Hamburg, of establishing stations at different points as far North as possible, from which expeditions could be sent out toward the Pole in favorable seasons.

February 4, 1880.

(1) DR. W. K. BROOKS presented a paper on Partial and Total Segmentation.

He showed by comparison of the eggs of a number of Molluscs, during the early stages of development, that the Lamellibranchs are the descendants of an ancestor whose eggs were few in number, large, and furnished with a food-yolk, like the eggs which are laid at present by representatives of the genus Nassa.

A discussion followed, participated in by Professor Martin and Mr. L. B. Fletcher.

(2) DR. J. R. MCD. IRBY read a communication on Crystallographic Calculations.

A number of new and useful formulae for calculating the angles and indices of crystal faces was given.

Philological Association.

January 9, 1880.

(1) The principal paper was by PROFESSOR ELLIOTT, on Noun-flexion in the Oldest French Texts.

The classification of inflexion is here founded exclusively on gender. The flexional phenomena up to the twelfth century are taken as the basis of this classification. The difficulties were stated which attend any system of classification whatever. The services particularly of Diez, Gaston Paris, Paul Meyer, Littré, Tobler and Lebinski were discussed. According to gender, the whole inflexional system divides itself naturally into two great categories, Masculines and Feminines: the former were split into two distinct sets, according to the variability or invariability of the Latin accent; the latter likewise give a double division, according to the final letter, whether vowel or consonant. G. Paris' and Tobler's theories, with reference to the Feminine anomalies of the *Passion du Christ*, were reviewed at length: the former's position was shown to be tenable and strongly supported by data.

Results of this investigation: Gender as a basis of classification for the Old French flexional system offers us fewer exceptions than any other principle. The system thus constituted held its own up to the twelfth century. The exceptions actually found did not belong to the first period of the language. In the twelfth century mutilations of this primitive system crept in: the first stage of confusion is represented by a simple encroachment of the casus obliquus in both numbers respectively, on the domain of the casus rectus; the second stage, by the flexional *s* being hung on to the already anomalously employed casus-obliquus. This state of things, however, has not yet become a general rule. Rhyme is yet the great conservator of synthetic forms, and prevents a headlong rush to the analytic state. Analogy and assimilation are the two strongest principles at work up to the thirteenth century in the process of leveling the flexional differences in the French language.

(2) PROFESSOR BRANDT then read a paper on Brücke's "Imperfect Vowels."

It was claimed that such a class of vowels, said to be peculiar to English, does not exist. The idea is based on prejudice, and on careless observation of English sounds.

(3) PROFESSOR LANMAN read a paper on Unconscious Duplication of Equivalent Linguistic Elements.

This explained the origin of the double article in combinations like *the Alcoran*, *le lierre*, *le loriot*, and of the double preterit-sign in *attackted*, *drownded*, *foaleded*, etc. The double plurals, like *breeches*, *belluses*, *gallusses* (*gallows-es*), were also noticed.

(4) PROFESSOR COOK reviewed Lounsbury's History of the English Language.

February 6, 1880.

(1) PROFESSOR BRANDT read the principal paper, which was on Verner's Law.

The paper read consisted of parts of a longer investigation upon Grimm's Law, viz.: the general introduction, and the part treating of Verner's Law. Grimm's Law was restated in three formulas with *x*, *y*, *z*. *Y* is the sonant stop; *z*, the surd one. Both are fixed quantities. *X* represents that very uncertain quantity called "aspirate." The advantage of these symbols was claimed to be, that they necessitate the inquiry into their phonetic value, which is too generally neglected when "hard, soft, aspirate," and the letters, e. g., *bh*, *dh*, *gh* are used. Parent-speech, General Teutonic, and High German are the only true representatives of three groups of languages affected by Grimm's Law. Then Verner's Law was discussed, which explains the large class of exceptions to the shifting of the formula "Parent-speech. *z*: G. T. *x*: H. G. *y*.," by the difference in the original accent.

(2) MR. J. W. BRIGHT read a paper on The Views of Begemann respecting the Teutonic Weak Preterite.

The aim of the paper was to present Begemann's attitude towards the "composition theory" along the line of its history from Bopp and Grimm to the present, and thus gradually to develop Begemann's own theory by its sharp and argumentative contrasts, and to indicate details of argument attaching to the whole discussion which yet await conclusive demonstration.

(3) PROFESSOR LANMAN read a paper on the Origin of the Belief in the Transmigration of Souls.

The belief may have arisen independently among the Egyptians, Shemites, and Aryans. Several Vedic passages supposed to contain the germs of the Metempsychosis were examined. The development of the doctrine in India was referred to the Post-Vedic age.

(4) MR. B. F. O'CONNOR read a paper on the Principles of Orthography of French verbs ending in *-eler* and *-eter*.

These verbs, numbering about 230, present the peculiarity that some of them double the consonant before mute *e*, whereas others under the same circumstances accent the preceding *e*. The reason for this distinction is unknown, and there is much confusion among grammarians on the subject.

A careful study of each verb shows that the principle which originally governed them was Etymology, and that they should be classified according to this principle. The simplest way out of the difficulty would be to conjugate them all alike.

(5) PROFESSOR CROSS read a paper on The Testamenta of the Twelve Patriarchs.

This showed the uncertainty of the results reached in attempting to establish the dependence of one document upon another, from isolated verbal coincidences; and that the argument for the previous acquaintance of the writer of the *Testamenta* with certain books of the New Testament is inconclusive, because the words advanced to support this view are not peculiar to the two alone, but are of common occurrence in other Greek writers and in the LXX.; and that the date usually assigned for its composition cannot be established.

Historical and Political Science Association.

The regular January meeting of the Association was postponed on account of the semi-annual examinations.

Metaphysical Club.

December 9, 1879.

(1) The principal paper, by MR. E. M. HARTWELL, was on Reflex Action and its Analogies in the Fixing of Belief.

The various factors of reflex action were discussed separately and in their relations to one another. Simple and tetanic muscular contraction were shown by experiments upon the nerve muscle preparation of a frog. Several experiments were made upon frogs, in order to show reflex action, indicating purpose without volition. The steps whereby the mind resolves its doubts or reaches its beliefs were pointed out as analogous to those in the reflex action of a brainless frog.

(2) MR. DAVID STEWART presented a communication on The Ethics of Belief.

This paper discussed the moral grounds of a belief in the supernatural, and pointed out the dishonesty of treating as positive fact, dogmas which are matters of doubt or dispute.

January 13, 1880.

(1) MR. ALLAN MARQUAND presented a translation, which he had made, of the treatise of Philodemus, *περὶ σημείων καὶ σημειώσεων*.

This treatise, recovered from the ruins of Herculaneum, at the end of last century, reveals to us the method of induction taught in the school of Zeno, the Epicurean. The inference passes from the known to the unknown by means of resemblance. The method is contrasted with the *κατ' ἀνασκευήν* of the rhetoricians, and arguments are presented to show that the method of resemblance underlies the other. Various objections are considered, and it is shown in a very interesting way that the method cannot be attacked, except by assumptions which can be obtained only by induction itself. In the treatment of inductive fallacies we are referred to a lost work of Demetrius, the Epicurean, where this subject is said to have been treated very compactly.

MR. C. S. PEIRCE remarked upon the value of this treatise to the *History of Inductive Logic* and Epicurean Philosophy.

(2) MR. C. W. NICHOLS read a paper on Moral Insanity as a Cause of Crime.

This paper, based upon M. Despine's *Psychologie Naturelle*, called attention to many cases of mania and monomania, and urged a more scientific and humane treatment of the morally insane.

(3) MR. W. S. PRATT offered an abstract of Grant Allen's *Physiological Aesthetics* (London and New York, 1877).

Starting with the doctrine that pleasure and pain are subjective concomitants of nervous states, Mr. Allen first distinguishes the truly aesthetic pleasures, and then discusses at length the stimulations, both actual and ideal, to which the sensory organs and the coördinating centres of the intellect are subject, with a view to an *a priori* determination of their relative aesthetic values. Applications of the conclusions reached are made to painting and sculpture, and especially to poetry. Attention was called by Mr. Pratt to the admirable method of the book, and to its importance as a treatise on the sensuous elements of aesthetic enjoyment.

February 10, 1880.

(1) The principal paper was by MR. W. S. PRATT on Helmholtz's Theory of the Development of Musical Scales.

After calling attention to a few of the scales now in use, the answers that Helmholtz gives to the questions, (I) Why are scales with determinate degrees universally used?; and (II) Why are certain degrees preferred to others? were discussed at length.

His answer to (1) was objected to, and the early development of *rhythm* suggested as a more satisfactory reason for the practice. This view was supported by *a priori* considerations, and by observations on the music of barbarous tribes. (2) His theory of the further progress of scale-development was divided into five parts: (*a*) The acoustic doctrines of partial-tones and of tone relationship; (*b*) The physiological doctrine that the ear is essentially a set of resonators sensitive to these partial-tones and to the natural kinships established by them; (*c*) Resting upon these, the mental tendency to choose scales containing only tones nearly akin to each other; the operation of which tendency is limited by (*d*) The smallest interval tolerated between consecutive notes, and by (*e*) The desire for uniform intervals. The interaction of these elements in the evolution of modern scales, was explained and illustrated.

A legitimate extension of this rationalization of the action of taste develops a large number of theoretical scales that are as yet unknown in practical use. The actual forms are often inferior in tonal correlation to the theoretical, and a fuller explanation is needed of the exclusion of the latter by the former. Helmholtz's failure to recognize the probability of some harmonic influence on the scales of even the most barbarous peoples, was also noted. In conclusion, a brief mention was made of the current dispute as to what shall be adopted as the standard scale.

(2) A paper on the Evolution of Nerves and Nervous Systems was read by MR. E. M. HARTWELL.

This gave an account of the investigations of Messrs. Romanes and Schaefer on the contractile and conductile tissues in the Medusid jelly fishes. It was claimed that they had demonstrated certain progressive stages of genesis and specialization in the nervous systems of various genera of the Medusæ; and that their results afforded new and valuable inductive evidence in favor of the deductive theory propounded by Mr. Herbert Spencer, concerning the development of the nervous system from undifferentiated protoplasm.

Mathematical Seminary.

November 19, 1879.

DR. STORY, on a *Generalized form of Analytical Triangle.*

The method of Newton's parallelogram or of the "analytical triangle," is independent of the angle between the coordinate axes, and may therefore be applied to any trilinear system to determine the nature of a curve in the vicinity of the intersection of any two axes, if the third coordinate be regarded as constant. If, therefore, the curve be referred to a bilinear system, we may, by regarding the infinite straight line as the third axis of a trilinear system, determine the nature of the curve at the infinite points of the bilinear axes, and the tangents (asymptotes) at the points where the curve cuts either axis. The *generalized analytical triangle* is equilateral and shows the coordination of the three origins (so to speak), viz: the origin, in the ordinary sense, and the infinite points of the bilinear axes. The coefficients of the equation of the curve are arranged in the triangle in rows parallel to the *three* sides according to the powers of the three coordinates which the corresponding terms would contain, if the equation were made homogeneous. The essential difference between this arrangement and that of the ordinary analytical triangle, is the use of the rows parallel to the third side.

December 22, 1879.

(1) Mr. Stringham: On Vector Ratios considered as Trigonometric Functions of Angles.

If α, β, δ form the vector sides of a right triangle, $(\alpha \perp \delta)$, then $\mathrm{cq}\,\frac{\beta}{\alpha} = \frac{\alpha}{\beta}$ is the quaternion cosine of the acute angle between α and β, and $\mathrm{sq}\,\frac{\alpha}{\beta} = \frac{\delta}{\beta}$ is the quaternion sine of the same angle. Starting from these two definitions, a complete quaternion trigonometry may be developed, giving analogues of all the formulae of the ordinary scalar trigonometry, such a trigonometry evidently including the scalar trigonometry as a special case. Thus the quaternion formula,

$$\mathrm{sq}\,\frac{\beta}{\alpha} + \mathrm{eq}\,\frac{\beta}{\alpha} = 1$$

gives at once the scalar formula

$$T^2\,\mathrm{sq}\,\frac{\beta}{\alpha} + T^2\,\mathrm{cq}\,\frac{\beta}{\alpha} = 1$$

If we consider complanar angles only, the two fundamental addition formulae are

$$\mathrm{sq}\left(\frac{\beta}{\alpha} + \frac{\gamma}{\beta}\right) = \mathrm{sq}\,\frac{\beta}{\alpha}\,\mathrm{cq}\,\frac{\gamma}{\beta} + \mathrm{cq}\,\frac{\beta}{\alpha}\,\mathrm{sq}\,\frac{\gamma}{\beta}\,,$$

$$\mathrm{cq}\left(\frac{\beta}{\alpha} + \frac{\gamma}{\beta}\right) = \mathrm{cq}\,\frac{\beta}{\alpha}\,\mathrm{cq}\,\frac{\gamma}{\beta} + \mathrm{sq}\,\frac{\beta}{\alpha}\,\mathrm{sq}\,\frac{\gamma}{\beta}\,.$$

(2) Mr. Van Velzer: On a Condition that the Total Differential Equation

$$P\,dx + Q\,dy + R\,dz + \ldots + T\,dv = 0$$

may admit of a single Primitive.

The condition is

$$\left\|\begin{array}{cccc} P & Q & R & \ldots\ldots T \\ \frac{d}{dx} & \frac{d}{dy} & \frac{d}{dz} & \ldots\ldots \frac{d}{dv} \\ P & Q & R & \ldots\ldots T \end{array}\right\| = 0,$$

i. e. any and every one of the symbolic determinants formed by taking three columns of the above matrix must vanish.

If there is a single primitive, let it be $\phi = 0$; then

$$P = m\frac{d\phi}{dx},\; Q = m\frac{d\phi}{dy},\; \ldots\; T = m\frac{d\phi}{dv}$$

and the above matrix becomes

$$\left\|\begin{array}{cccc} P & Q & R & \ldots T \\ \frac{d}{dx} & \frac{d}{dy} & \frac{d}{dz} & \ldots \frac{d}{dv} \\ m\frac{d}{dx} & m\frac{d}{dy} & m\frac{d}{dz} & \ldots m\frac{d}{dv} \end{array}\right\|\phi$$

Consider the first three columns. Since

$$\frac{d}{dy}\,m\,\frac{d\phi}{dz} = \frac{dm}{dy}\cdot\frac{d\phi}{dz} + m\cdot\frac{d}{dy}\,\frac{d\phi}{dz}\;\ldots$$

$$\frac{d}{dz}\,m\,\frac{d\phi}{dy} = \frac{dm}{dz}\cdot\frac{d\phi}{dy} + m\cdot\frac{d}{dz}\,\frac{d\phi}{dy}\,,$$

$$\left|\begin{array}{ccc} P & Q & R \\ \frac{d}{dx} & \frac{d}{dy} & \frac{d}{dz} \\ m\frac{d\phi}{dx} & m\frac{d\phi}{dy} & m\frac{d\phi}{dz} \end{array}\right|$$

$$= \frac{1}{m}\left|\begin{array}{ccc} P & Q & R \\ \frac{dm}{dx} & \frac{dm}{dy} & \frac{dm}{dz} \\ m\frac{d\phi}{dx} & m\frac{d\phi}{dy} & m\frac{d\phi}{dz} \end{array}\right| + \left|\begin{array}{ccc} P & Q & R \\ \frac{d}{dx} & \frac{d}{dy} & \frac{d}{dz} \\ \frac{d\phi}{dx} & \frac{d\phi}{dy} & \frac{d\phi}{dz} \end{array}\right|$$

The first determinant of the right hand member vanishes, because of the identity of the first and third rows, and the second vanishes because $\frac{d}{dy}\frac{d\phi}{dx} = \frac{d}{dz}\frac{d\phi}{dy}$, etc. The same is true of any other three columns of the first matrix.

(3) Mr. Franklin made some remarks on the Remainder in Taylor's Theorem.

Writing $R_n = \frac{h^n}{n!} f^n(x + \vartheta h)$, the limit of ϑ as h approaches zero is $\frac{1}{n+1}$

January 21, 1880.

(1) Mr. Stringham: A Generalization, for n-fold Space, of Euler's Equation for Polyhedra.

Let N_0, N_1, N_2, N_3, . . . N_n denote respectively the number of zero-, one-, two-, three-, . . . n-dimensional boundaries of a complete geometrical figure in n-fold space. Then the generalized formula is,

$N_0 + N_2 + \ldots + N_n = N_1 + N_3 + \ldots + N_{n-1} + 2$, if n be even;

$N_0 + N_2 + \ldots + N_{n-1} = N_1 + N_3 + \ldots + N_n$, if n be odd.

For these equations are true for the simplest figures, and they are not invalidated by adding to such figures any number of $(n$-$1)$-dimensional boundaries.

A description was given of three *regular* geometrical figures belonging to 4-fold space, additional to the three described at the last meeting of the Scientific Association; viz., (1) the 4-*fold Ikotetroid* a self-reciprocal figure; (2) the 4-*fold Tetradekoid*; and (3) its reciprocal, the 4-fold *Hebdomekontoid*. These six seem to complete the list of regular figures in 4-fold space, excluding stellated figures. The analogues, in n-fold space, of the tetrahedron, cube, and octahedron were also described.

This paper was discussed by Professor Sylvester, Mr. C. S. Peirce, Dr. Story, and Mr. Mitchell.

(3) Dr. Story: On the Reduction, by Determinants, of the expression for Radius of Curvature, given in Salmon's Higher Plane Curves, p. 83.

The determinant to be calculated is,

$$0 = \left|\begin{array}{llll} a, & h, & (n-1)\,L-gz, & 0 \\ h, & b, & (n-1)\,M-fz, & 0 \\ g, & f, & 0\;\; -cz, & n-1 \\ L, & M, & 0\;\; -oz, & -z \end{array}\right|$$

$= (n-1)^2\,(bL^2 - 2hLM + aM^2) + z^2 H$, where H is the Hessian. Hence $(bL^2 - 2hLM + aM^2) = \frac{-z^2 H}{(n-1)^2}$, and $R = \pm\frac{(n-1)^2\,(L^2 + M^2)^{\frac{3}{2}}}{z^2 H}$.

(3) Professor Sylvester: On a Probable Generalization of the Theorem,

$$\frac{x^p - 1}{x - 1} = X^2 \pm pY^2\,.$$

Commemoration Day.

The fourth anniversary of the Johns Hopkins University will be observed on Monday, February 23d, 1880, by a public ceremony in Hopkins Hall, when it is expected that three Matriculates will be advanced to the degree of Bachelor of Arts, and one Bachelor of Philosophy will be promoted to the degree of Doctor of Philosophy. After the public exercises are concluded there will be a social assembly of the officers and students and their friends in the Library and other Halls of the University. On similar occasions, in previous years, the President of the University has delivered an address and the other speakers have been as follows:

February 22, 1876.—Addresses by Reverdy Johnson, Esq., and President Eliot, of Harvard University, followed by the President's Inaugural Address.

Feb. 22, 1877.—Addresses by Professors Sylvester and Gildersleeve, and the reading of a Poem by James Russell Lowell.

Feb. 22, 1878.—Addresses by Hon. Geo. Wm. Brown, Professor Remsen, and President Eliot, of Harvard University.

Feb. 22, 1879.—An address by Judge Geo. W. Dobbin; a Latin congratulation by Professor C. D. Morris, and an Oration by President White, of Cornell University.

At the close of the public exercises in 1879, the college graduates resident in Baltimore, with their invited guests, partook of a collation, at which Hon. S. T. Wallis presided, and several speeches were made.

Additions to the Roll of Students.

(For other lists see pp. 3-5 and 20, University Circulars).

Della Torre, Frank University of Virginia.	Reisterstown, Md.	*Chemistry.*
Downs, Howard F. Baltimore City College, 1876.	64 William St.	*Matriculate.*
Howard, Curtis C. S. B., Ohio State Agricultural College, 1878	267 N. Eutaw St.	*Chemistry.*
Patterson, J. Wilson A. B., Princeton College, 1863.	79 Park Ave.	*Greek.*
Sutro, Alfred E. Loyola College.	198 Bolton St.	*Candidate.*

Any persons who have copies of the First Annual Report of the University that they are willing to part with, will confer a favor by sending them to the University.

The first number of the American Journal of Philology, under the editorial charge of Professor Gildersleeve, is expected to appear on Monday, Feb. 23, 1880.

AMERICAN JOURNAL OF MATHEMATICS.

PURE AND APPLIED.

Editor in Chief, J. J. Sylvester, Professor of Mathematics; Associate Editor in Charge, William E. Story, Associate in Mathematics; with the co-operation of Simon Newcomb, H. A. Newton and H. A. Rowland.
Issued under the auspices of the Johns Hopkins University.

Published in the quarto form and in numbers appearing four times a year. Subscription price per Volume, of about 384 pages, $5.00; price per number $1.50. Vol. I, 1878–79 (388 pp., 4 plates), can still be furnished at the subscription price.
All communications should be addressed to the Associate Editor in charge.

CONTENTS FOR FEBRUARY, 1880, Vol. II. No. 4.

I. Tables of the Generating Functions and Ground-Forms for Simultaneous Binary Quantics of the First Four Orders, taken two and two together. By J. J. Sylvester, assisted by F. Franklin.
II. Remarks on the Preceding Tables. By J. J. Sylvester.
III. A New General Method of Interpolation. By Emory McClintock.
IV. A Certain Class of Cubic Surfaces treated by Quaternions. By A. B. Chace.
V. On the Ghosts in Rutherfurd's Diffraction Spectra. By C. S. Peirce.
VI. On a Theorem for Expanding Functions of Functions. By Emory McClintock.
VII. Preliminary Notes on Mr. Hall's Recent Discovery. By H. A. Rowland.
VIII. On Certain Ternary Cubic-Form Equations. Excursus A. On the Divisors of Cyclotomic Functions. By J. J. Sylvester.
IX. A Quincuncial Projection of the Sphere. By C. S. Peirce.

AMERICAN CHEMICAL JOURNAL.

Edited, with the aid of Chemists at Home and Abroad,

By IRA REMSEN, Professor of Chemistry in the Johns Hopkins University.

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Subscriptions and communications should be addressed to the Editor.

CONTENTS FOR FEBRUARY 1880, Vol. I. No. VI.

On a Method for the Proximate Analysis of Plants, by H. B. Parsons.
On the Estimation of Phosphoric Acid as Magnesic Pyro-Phosphate, by F. A. Gooch.
Laboratory Notes, by A. Michael.
  I. On Monethyl-Phthalate.
  II. On a New Formation of Ethyl-Mustard Oil.
  III. On the Preparation of Methyl-Aldehyde.
  IV. On the "Migration of Atoms in the Molecule," and Reimer's Chloroform Aldehyde Reaction.
On the Oxidation of Substitution Products of Aromatic Hydrocarbons:
  IV. On the Oxidation of Orthotoluenesulphamide, by Ira Remsen and C. Fahlberg.
On an Unusual Case of Electrolysis, by J. W. Mallet.
Reports, Notes, &c., by J. W. Mallet, the Editor, and others.

Studies from the Biological Laboratory.

Edited by H. Newell Martin, Professor of Biology in the Johns Hopkins University.

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I. On the respiratory function of the internal intercostal muscles. By H. Newell Martin and Edward Mussey Hartwell.
II. Observations on the physiology of the spinal cord. By Isaac Ott.
III. On the effect of two succeeding stimuli upon muscular contraction. By Henry Sewall.
IV. On the so-called heat dyspnœa. By Christian Sihler.
V. A self-feeding chronograph pen. By H. Newell Martin.
VI. Observations upon the early stages in the development of the fresh water pulmonates. By W. K. Brooks.
VII. The development of *amblystoma punctatum*. By S. F. Clarke.

Price per number $1.00. No. I, 1879, (91 pp, 4 plates) can still be furnished. All communications should be addressed to the Editor.

AMERICAN JOURNAL OF PHILOLOGY.

Edited, with the co-operation of leading scholars, by B. L. Gildersleeve, Professor of Greek in the Johns Hopkins University.

This Journal will be open to original communications in all departments of Philology, classical, comparative, oriental and modern; yet a large portion of the space will be given up to condensed reports of current philological work, and arrangements have been made to present regularly summaries of the chief articles in the leading philological journals of Europe, while a close watch will be kept over the fragmentary and occasional literature to which the isolated American scholar seldom has full access. The reviews of books will be intrusted as far as possible to specialists; and it is hoped that the Journal will meet a want that has long been acknowledged among American scholars, and serve as a means of inter-communication and as an organ of independent criticism.
The Journal will be in the ordinary review form, four numbers to constitute a volume, of from 400 to 500 pages, one volume to appear each year.
The subscription price will be three dollars a year, payable upon the receipt of the first number.
Vol. I. No. I. is now ready and contains original articles by Goodwin of Harvard, Carter and Packard of Yale, Lanman of the Johns Hopkins University, Merriam of Columbia College, T. Davidson of Boston, and the Editor, besides reviews of books and notices of journals by well-known specialists. Articles have been promised for early numbers by Short of Columbia, Garnett of Annapolis, F. D. Allen of Yale, Morris, Brandt and Elliott of the Johns Hopkins University.
All communications should be addressed to the Editor.

Copies of the Johns Hopkins University Circulars may be obtained, as soon as published, of Messrs. CUSHINGS *&* BAILEY, *No.* 62 *West Baltimore Street, Baltimore. Price* 5 *cents each.*

JOHNS HOPKINS UNIVERSITY CIRCULARS.

Published with the approbation of the Board of Trustees.

No. 4.] BALTIMORE, APRIL, 1880. [PRICE 5 CENTS.

CALENDAR.

February 18—May 5.	**Professor Gildersleeve's Readings in the Greek Tragic Poets.**
February 21—April 24.	**M. Rabillon's Readings (in French) in French Literature.**
March 26—30.	**Spring Recess.**
February 23—May 3.	**Prof Morris's Course on British Thought and Thinkers.**
April 2—May 28.	**Dr. H. C. Adams's Course on National Debts.**

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MEETINGS OF SOCIETIES, Etc.

Scientific. First Wednesday of each month, at 8 P. M. Next meeting, April 7. S. F. Clarke, Sec'y.

Philological. First Friday of each month, at 12 M. Next meeting, April 2. C. R. Lanman, Sec'y.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, April 16. H. B. Adams, Sec'y.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, April 13. Allan Marquand, Sec'y.

Biological. Thursday of each week, at 4 P. M.

Mathematical Seminary. Third Wednesday of each month, at 8 P. M. Next meeting, March 21.

Greek Seminary. Wednesday of each week, at 12 M.

PUBLIC LECTURES.

Lectures are in progress in Hopkins Hall at 5 P. M.:

Prof. Morris, on *British Thought and Thinkers*, Mondays, till May 3.

Prof. Gildersleeve, on the *Greek Tragic Poets*, Wednesdays, till May 5.

Dr. H. C. Adams, on *National Debts*, Fridays, till May 28.

M. Rabillon, on *French Literature*, Saturdays, till April 24.

COMMEMORATION DAY.

At the opening of the University, the Trustees determined in place of a midsummer commencement, to observe the 22d of February as a Commemoration Day, and this year, as this date fell on Sunday, Monday, February 23d, was so celebrated.

The exercises were held in Hopkins Hall, at 8 P. M., and were attended by the Trustees, the Academic Staff, the Fellows and Students (who entered in procession), and by a large company of gentlemen and ladies, filling the hall and adjacent passages to their utmost. The proceedings were as follows:

I. An *Opening Address* was delivered by **PRESIDENT GILMAN**, who welcomed the officers, students and friends of the University to the Fourth Commemoration. In place of any general discourse upon higher education he briefly described the present condition of the University. Beginning with the Humanities, he touched upon the progress here made in the encouragement of studies in Language, Literature, Philosophy and History, and he called attention to the first number of the *American Journal of Philology*, just issued under the editorial care of Professor Gildersleeve. He next referred to the work which has been done in Mathematics and Physics, described in a recent circular of the University, and finally to the scientific laboratories of Physics, Chemistry and Biology, with the last of which is connected the Sea-side Zoölogical Station. From the past he drew a prophecy of the future, and expressed the hope that this new foundation would be a benefit to every inhabitant of Baltimore, and would also be a helper in the advancement of science and literature wherever learning is encouraged.

II. *A Statement from the Board of Trustees* was then read by **MR. GALLOWAY CHESTON**, President of the Board, as follows:

At a meeting of the Trustees, Feb. 23, 1880, the following minute drawn up by President Gilman, at the suggestion of a member of the Board; was unanimously adopted and ordered to be read at the fourth anniversary, as a public recognition of the diligence and progress of the students, and of the ability, fidelity and wisdom of the various bodies which compose the academic staff.

The Trustees are particularly pleased to be assured that during nearly four years there has not been reason for any officer of this institution to censure a single student for disorder or discourtesy; that the halls which are daily occupied by scores of young men are not defaced by marks of mischief or carelessness; that the examinations, as conducted by impartial judges, bear testimony to efficient progress in study; and that those who have won degrees have also won the confidence and regard of their instructors, and are worthy to win, in society, positions of usefulness and honor.

In the opinion of the Trustees, the maintenance of this high standard has been due in a great measure to the system of Fellowships. With scarce an exception, those who have held this favorable position have been exemplary in their devotion to lofty pursuits, and have given both to those who are older and to those who are younger in academic life the encouragement of their well-trained enthusiasm in the pursuit of literature and science, and of their manly aspiration for all that is good and true.

The Associates of this university have also been charged with most important and varied duties, and have borne their burdens well. Some of their number have received commendation, far beyond our walls, for the valuable papers they have published in the physical, mathematical and biological sciences; others have printed most creditable contributions to Philology and History; several of them have given public courses of lectures to large and appreciative audiences; and all have been skillful and co-operative in the organition and instruction of classes, under the manifold difficulties of a foundation.

The aid received from Lecturers connected with other institutions deserves grateful acknowledgment.. Several of the most eminent professors of this country and one distinguished German have given us their valuable aid.

Upon the Professors has fallen the responsibility of guiding the institution upon the principles adopted by the Trustees. It is fortunate that this body includes those who are able to advance the sciences to which their lives are devoted. By their own investigations, by quickening younger men, and by collecting and publishing periodically the papers of their colleagues in this and other institutions, they have done their part for the advancement of learning and the diffusion of knowledge; while their devotion to the work of teachers has surrounded them with pupils many of whom are likely in their turn soon to be known both as teachers and "researchers."

In mentioning with special honor the name of Professor Sylvester, the Trustees are confident that all his colleagues and scholars will unite in congratulating him, that, with perennial vigor and unequalled industry, he is still carrying forward those profound investigations which have given him renown among the foremost of the mathematicians of our day.

III. An *Ode to The Johns Hopkins University*, was then read by the author, **MR. SIDNEY LANIER.**

How tall among her sisters, and how fair,—
How grave beyond her youth, yet debonair
As dawn, 'mid wrinkled *Matres* of old lands
Our youngest *Alma Mater* modest stands!
In four brief cycles round the punctual sun
Has she, old Learning's latest daughter, won
This grace, this stature, and this fruitful fame.
Howbeit she was born
Unnoised as any stealing summer-morn.
From far the sages saw, from far they came
And ministered to her,
Led by the soaring-genius'd Sylvester
That, earlier, loosed the knot great Newton tied,
And flung the door of Fame's locked temple wide.*
As favorable fairies thronged of old and blessed
The cradled princess with their several best,
So, gifts and dowers meet
To lay at Wisdom's feet
These liberal masters largely brought—
Dear diamonds of their long-compressèd thought,
Rich stones from out the labyrinthine cave
Of research, pearls from time's profoundest wave
And many a jewel brave, of brilliant ray,
Dug in the far obscure Cathay
Of meditation deep—
With flowers, of such as keep
Their fragrant tissues and their heavenly hues
Fresh-bathed forever in eternal dews—
The violet with her low-drooped eye,
For learnèd modesty,—
The student snow-drop, that doth hang and pore
Upon the earth, like Science, evermore,
And underneath the clod doth grope and grope,—
The astronomer heliotrope,
That watches heaven with a constant eye,—
The daring crocus, unafraid to try
(When Nature calls) the February snows,—
And patience' perfect rose.

---

* An algebraic theorem announced by Newton was demonstrated and extended by Sylvester.

Thus sped with helps of love and toil and thought,
Thus forwarded of faith, with hope thus fraught,
In four brief cycles round the stringent sun
This youngest sister hath her stature won.

Nay, why regard
The passing of the years? Nor made, nor marr'd,
By help or hindrance of slow Time was she:
O'er this fair growth Time had no mastery:
So quick she bloomed, she seemed to bloom at birth,
As Eve from Adam, or as he from earth.
Superb o'er slow increase of day on day,
Complete as Pallas she began her way;
Yet not from Jove's unwrinkled forehead sprung,
But long-time dreamed, and out of trouble wrung,
Fore-seen, wise-plann'd, pure child of thought and pain,
Leapt our Minerva from a mortal brain.

And here, O finer Pallas, long remain,—
Sit on these Maryland hills, and fix thy reign,
And frame a fairer Athens than of yore
In these blest bounds of Baltimore,—
Here, where the climates meet
That each may make the other's lack complete,—
Where Florida's soft Favonian airs beguile
The nipping North,—where nature's powers smile,—
Where Chesapeake holds frankly forth her hands
Spread wide with invitation to all lands,—
Where now the eager people yearn to find
The organizing hand that fast may bind
Loose straws of aimless aspiration fain
In sheaves of serviceable grain,—
Here, old and new in one,
Through nobler cycles round a richer sun
O'er-rule our modern ways,
O blest Minerva of these larger days!
Call here thy congress of the great, the wise,
The hearing ears, the seeing eyes,—
Enrich us out of every farthest clime,—
Yea, make all ages native to our time,
Till thou the freedom of the city grant
To each most antique habitant
Of Fame,—
Bring Shakspere back, a man and not a name,—
Let every player that shall mimic us
In audience see old godlike Aeschylus,—
Bring Homer, Dante, Plato, Socrates,—
Bring Virgil from the visionary seas
Of old romance,—bring Milton, no more blind,—
Bring large Lucretius, with unmaniac mind,—
Bring all gold hearts and high resolvèd wills
To be with us about these happy hills,—
Bring old Renown
To walk familiar citizen of the town,—
Bring Tolerance, that can kiss and disagree,—
Bring Virtue, Honor, Truth, and Loyalty,—
Bring Faith that sees with undissembling eyes,—
Bring all large Loves and heavenly Charities,—
Till man seem less a riddle unto man
And fair Utopia less Utopian,
And many peoples call from shore to shore,
The world has bloomed again, at Baltimore!

IV. *Bestowal of Degrees.* The degrees of A. B., and of Ph. D., were then conferred by the President of the University.

Professor C. D. Morris first presented the candidates for the Baccalaureate degree, introducing them with the following remarks:

I have been asked to present to the Trustees the three young men who have been judged by the Board of Examiners worthy of receiving the A. B. degree. As a preface to the actual ceremony, I may be permitted to make one or two remarks on the nature of the training these young men have received since they have been with us. All that I can say is, indeed, already in print in the various circulars issued by the University; but perhaps in regard to such printed matters Horace's rule does not hold as to the superiority of the eye to the ear, and it may do no harm to call attention in this way to some of the peculiarities of our system as regards undergraduate students.

In the first place, when a student has passed the matriculation examination he is permitted to select his lines of study, so as best to suit his probable future career. But this does not mean that it is assumed that he is then competent fully to understand what courses are most suitable for his purpose. His freedom is limited by the fact that he must be guided by the advice of one of the board of instructors, to whose special care he is assigned by the President; and the adviser is himself restricted, in the courses he is permitted to authorize, by the regulation that no student shall be honored with the degree of A. B. unless he has a fair knowledge of at least one ancient and two modern languages, has shown that he possesses a good acquaintance with elementary mathematics, and has cultivated his powers of observation by pursuing in the laboratories of the University at least one branch of physical science. Some part of this necessary minimum the student will possess at his matriculation. But he must during his undergraduate career pursue at least five courses of study, two of them, which we call ***major courses***, implying that he has acquired a real mastery of the subjects, and three others, ***minor courses***, which he has studied well, but not so extensively. It must be admitted that, while such a training does not guarantee that a student shall go forth from our doors equipped with a little knowledge on every conceivable subject, it does offer him a culture which is broad and liberal and yet allows him to direct his attention chiefly to the lines of work which his circumstances may show to be most desirable for him.

In the second place, I should like to say a word on the time element in our undergraduate courses. Our matriculation standard is placed, and will no doubt be kept, at a high level, so that it may fairly be assumed that a student who passes it with credit is fully on a par with the average American sophomore. After this the time that must elapse before the A. B. degree is reached is not with us determined by any hard and fast line. A definite amount of work is prescribed, which the student has to absolve, be the time longer or shorter. The one thing that is certain is that mere lapse of time will not help him in the slightest degree. But every encouragement is offered to the able and diligent student to use his best efforts to put his work behind him as fast as he can; while the student who, from unfavorable circumstances of any sort, is unable to use any great expedition, is not made to feel that he is left behind by his contemporaries in any sense that need lower his self-respect.

The result of this system is seen in the absolutely universal diligence that pervades the whole place. I have had considerable experimental acquaintance with other seats of learning, and I assert with the greatest confidence that in no place of which I have any knowledge [illegible] anything like the universal spirit of work which prevails here. We have students [illegible] of various degrees of capacity and [illegible] [illegible] believe that the class of idlers is represented [illegible] by a single specimen.

Of the three young men whose names I shall presently read, one has been here with us and each of the others two years and a [illegible] since the completion of their matriculation; and in June last the degree was conferred on a student who had been here but two years.

[illegible] special attention to these facts, as I think a misapprehension exists as to the length of time required for graduation here. [illegible] of this comparative shortness of undergraduate time is [illegible] our students do not think it necessary to leave as soon as they have gained their A. B. Of the three who graduated a year ago [illegible] are still studying here; and I believe that it is the intention of the three whom I am to present to-night to do the same thing.

I have only one more remark to make. In nearly, if not quite, all the examinations which these young men have successfully passed in their several subjects, they have satisfied the judgment of examiners who have had nothing to do with their instruction. I may mention, as one of these, Prof. [illegible], of the City College, and Prof. W. [illegible] of Harvard University.

He then called to the platform, and introduced by name, the three candidates:

1. [illegible], of Baltimore, who graduated at the City College in [illegible], and has finished major courses in Latin and History, and minor courses in German, French and Physics.

2. CARL E. GRAMMER, of Baltimore, a former student of the City College, who has here pursued major courses in Greek and Latin, and minor courses in History, German and Chemistry.

3. EDMUND A. JARVIS, of Baltimore, who received his previous training at Mr. G. G. Carey's School, Baltimore, and has followed major courses in Chemistry and Biology, and minor courses in Latin, Greek and German.

With the assent of the Trustees, these matriculated students were then advanced to the degree of Bachelor of Arts.

Professor Sylvester, on behalf of the Examiners, then presented as a candidate for the Degree of Doctor of Philosophy; MR. FABIAN FRANKLIN, of Baltimore, a graduate in 1869, of Columbian University, Washington, where he received the degree of Ph. B., and recently a Fellow of this University.

Professor Sylvester referred to the Thesis of Mr. Franklin on Bipunctual Coordinates, which has been printed (Am. Jour. of Math. I, pp. 148-173), and to the attainments exhibited in a series of formal examinations. He mentioned that this is the second occasion only in this University when the doctorate has been conferred upon a graduate offering Mathematics as his principal subject, Dr. Craig, now of the U. S. Coast and Geodetic Survey, being the first to receive this degree.

Mr. Franklin then came up and was admitted to the degree of Doctor of Philosophy.

Hon. C. J. M. Gwinn, on behalf of the Board of Trustees, then addressed PROFESSOR HENRY A. ROWLAND, saying to him that the Trustees had received a communication, bearing the signatures of several of his colleagues and of three professors of Mathematics and Physics at Harvard and Yale, in which they ask that in recognition of his attainments in Physics, manifested particularly in his investigation of the mechanical equivalent of heat, he should receive the degree of Doctor of Philosophy, *honoris causâ*. To this request the Trustees had unanimously given their assent.

Professor Rowland then came forward and was admitted to this honorary degree.

V. *Vocal Music.* The Latin Ode, *Integer Vitae*, was then sung by a choir of male voices.

VI. The programme next called for a Congratulatory Address.

President Gilman alluded to the oration given here in 1879 by President White and to the poem read in 1877 by Professor Lowell, both of whom were soon sent abroad, one to represent this country at Berlin, and the other at Madrid and at London. Now, he said, we are *honored* with the presence of the distinguished statesman who sent them abroad—a gentleman whose addresses in other academic assemblies have added to the well-earned fame he has acquired at the bar and in the Cabinet. Without knowing whether he would consent to speak, he ventured to present to the audience Hon. WILLIAM M. EVARTS, U. S. Secretary of State.

Mr. Evarts said that he had not expected to take any other part in this assembly than that of a silent and admiring visitor, but if there was anything he had learned in regard to college professors and university men it was that they were a great deal wiser in their policy than they were in their speech. I would have you know, however, he continued, that usually when I am present on occasions like this the solicitude is, not that I will not speak, but that I will never stop. Your President, I fear, has given me a rather bad name, by saying in effect that whenever I see a distinguished man who is a friend of the Johns Hopkins University, I send him out of the country. I have not been unfamiliar, I may say, with the beneficence with which Mr. Hopkins endowed this institution, nor of the great advantages which it has already brought to this community. The university will forever be an honor to him and all who bear his name. Neither am I unaware of the great and crowning aid which has been gained by bringing you, Mr. President, and choosing you as its head. Of the plans and methods of the University I have been unaware until this evening; but I do know that you have been spared those small beginnings and slow developments that have marked the early careers of the great universities of this and other countries. The annual revenue of this University, if I am not mistaken, is greater than the entire fund of Yale College in the early part of this century. So much has been given at the start that it calls upon the professors and the students to see that the growth and fruition shall be commensurate with the seed that has been planted. I believe that the congratulatory address occupies a somewhat anomalous place in the programme, because there is really no need for any congratulation, and that it stands as a kind of parenthesis which, as grammarians tell us, may be omitted without detriment to the sense.

However, I congratulate the city of Baltimore and the State of Maryland and the country at large upon the progress of this institution, which is designed to inculcate order, make plainer law and establish the principles of good government—for, as Aristotle says, "It is by education that I learn to do by choice what otherwise I should be compelled to do by force."

VII. The exercises in the Hall concluded with the singing of "*Non Nobis Domine Sed Nomini Tuo da Gloriam*," from the Psalter.

A social assembly of the members of the University and their friends was subsequently held in the library and other rooms of the University. It was estimated that about eight hundred ladies and gentlemen participated in the festival. The tablet commemorative of Johns Hopkins was decorated with smilax, the motto of the University, VERITAS VOS LIBERABIT, in evergreen letters, was hung above the platform, and the halls were ornamented with flowers from Clifton, the former residence of the Founder.

LIBRARIES OF BALTIMORE.

Library of the Johns Hopkins University.

DR. WM. HAND BROWNE, *Librarian.*

As is well known to members of the University, the library has four departments:—

(*a*) A general reference collection of books, including not only cyclopaedias and dictionaries, but copies of the works of great authors, ancient and modern, in different branches of literature and science.

(*b*) Several special collections of books which have been bought as the working apparatus of those departments of study now instituted among us, from lists which have been furnished by the several instructors.

(*c*) A transient collection of *new* books, English, French and German, brought here for examination as soon as published, sometimes by purchase, and sometimes by the courtesy of dealers.

(*d*) A very full collection of current periodical literature, so selected as to supplement the lists of the Peabody, the Mercantile Library, and other reading rooms of Baltimore.

For the information of those at a distance the following statement of the plans followed in the formation of the library has been prepared:

The organization of the library, which was begun in 1876, under the supervision of the late Mr. Thomas C. Murray, was conducted in conformity with certain clear and definite principles, previously formed by the Trustees. It was intended that it should be a part of the working machinery of the University, and was so constructed and ordered as to render the most efficient service to the work carried on. For this purpose it was necessary that it should possess, as far as practicable, first, the essential or most important works treating of those studies and researches which were actually in progress at any time; and, secondly, a fair proportion of such books as, without precisely belonging to the former class, might give the student or investigator valuable aid and furtherance in his work. It was desired to make the library so far encyclopaedic, that no profitable branch of independent study or reflection could be entered upon, to which at least some clue or guide might not be found here to help the student on his way.

To secure this twofold end, there has been established a small but compact library of general reference, and a series of special libraries for each department of work, arranged, as far as possible, on the plan of keeping kindred subjects, such as mathematics and physics, closely together — the growth of each of these special libraries to be determined by the actual needs of the department to which it belongs, and that of the general library by the wants of the whole. It is also proposed to place in the working-rooms of each department a collection of the most indispensable hand-books, and works of most frequent reference, for convenient consultation while work is in progress.

In order that the University, in all its branches, may keep fully abreast of the rapid progress of thought and discovery, a large proportion of the leading journals in the chief departments of knowledge are taken; so that scarce any considerable step can be made, or fact of moment occur, but the library has prompt note of it in the most authentic shape.

As, moreover, many valuable works are constantly appearing which do not precisely fall within the scope of our actual needs, and yet it is well to see and to have the opportunity of acquiring, arrangements have been made for placing on the tables, from time to time, assortments of such books, as soon as possible after their appearance, for inspection and purchase, at pleasure, by members of the University. Others, again, are bought, lent under certain limitations, and finally resold at a somewhat reduced price. The small loss that this arrangement entails is more than compensated by the advantages it offers.

Such are the main principles on which the library is conducted, it is believed, to the general advantage and satisfaction.

The library at present contains 7800 bound volumes and about 800 unbound, including pamphlets, but not periodicals.

The number of periodicals taken, exclusive of the issues of publication societies, is 265, of which 26 are received in exchange for journals proceeding from the University, 7 are gratuitous, and 232 are subscribed for. They are published in England, Scotland, France, Germany, Austria, Holland, Belgium, Italy, Greece, India, and the United States, and represent all the leading branches of knowledge and literature. A printed list of the periodicals taken by the principal libraries of Baltimore has been published by the University.

The library is open to all members of the University from 9 A. M. till 10 P. M., and books may be taken out, under certain limitations, for reading at home. The reading-room is large and well lighted, and contains the general reference library and current files of periodicals, while the rooms containing the special libraries are open to all who prefer to carry on their studies there. Readers have free access to all the shelves, and to the card-catalogue which is kept always complete to date.

Peabody Institute Library.

MR. P. R. UHLER, *Librarian.*

This library was founded in 1857 by Mr. George Peabody, as a part of the Institute which bears his name. The collection was begun in 1861, and it was opened to the public in 1866, with a nucleus of 16,000 volumes. It now contains 67,850 volumes, representing every branch of literature and science, of which about one-tenth are works of fiction. It is especially rich in large and costly works of science and art, which but few private libraries can afford, and in some departments is better provided than any other in the country. It is a library for reading and reference only.

The new hall, in the east wing of the Institute, where its stores are now assembled, is admirably designed, both for beauty and convenience. The cases are arranged in alcoves with double windows, so that, whenever the growth of the library may require it, the number of cases, and consequently the storage capacity of the hall, can be doubled.

The reading-room is open to the public from 9 A. M. to 9 P. M. In this room are arranged encyclopaedias, dictionaries, and other works of general reference, which readers can consult at pleasure; while books from the alcoves are brought as desired by the assistants.

The work of building up the library is steadily carried on. There have lately been added to its shelves the publications of the Master of the Rolls, and of the Record Commission, of Great Britain; new issues of the Ray Society, the Palaeographical Society, the Société de l' Orient Latin, the Ratcliffe Astronomical Observations, and other works of great value.

Library Company of the Baltimore Bar.

MR. J. HOLMES CONVERSE, *Librarian.*

This company, which is a voluntary association of members of the Baltimore Bar, was incorporated by an Act of Assembly in 1840. It is supported altogether by subscription, the yearly payment being ten dollars. It is used for reference only; but books from its shelves may be carried into the courts and there referred to as needed. The affairs of the Company are managed by a president and board of five directors, elected annually.

The present membership is 327. The number of volumes is nearly 8000, including almost complete sets of the English and American reports, and most of the latest text-books. It is open every day, except on Sundays and legal holidays, from 9 A M. to 11 P. M. during ten months of the year, and in July and August from 9 A. M. to 6 P. M.

Library of the Maryland Historical Society.

Mr. J. G. Gatchell, *Librarian.*

This Society was founded in 1844. In 1855 its library, which, though not large, was a very valuable collection, was increased by the transfer to it of the books of the Library Company of Baltimore. It now contains 15,000 volumes and 2000 pamphlets.

This collection is especially rich in the department of history—general, State and local. It is also well supplied with works of voyages and travels, and the leading writers on political science; has a good collection of maps, and very full files of newspapers. Beside these, the other departments of knowledge are fairly well represented; and it possesses many rare works and bibliographical curiosities. Among its manuscript collections it includes many valuable papers, chiefly bearing upon the history of the State. Among these are: Maryland State papers, 1637–1776; Gilmor Maryland papers, 1689–1794; Revolutionary papers of Gen. Gist, 3 vols. fol.; Miscellaneous Maryland MSS. 13 portfolios; Abstract of Maryland Documents in the State-Paper Office, London, prepared by Mr. Henry Stevens, and presented to the Society by Mr. George Peabody, filling eleven cases, and containing abstracts of over seventeen hundred documents, covering the period 1626–1780.

It has also an interesting collection of coins, medals, and tokens.

The rooms are open daily from 10 A. M. to 2 P. M. The membership-subscription is five dollars yearly; but all students or others seeking information are made welcome to the rooms, and every assistance rendered them in their researches.

Mercantile Library Association.

Mr. J. W. M. Lee, *Librarian.*

This association was organized in 1839, more especially for the advantage of clerks and others employed in business houses, though the use of the books was extended to all members of the community, on the payment of a slightly increased subscription. It has grown steadily, if not rapidly, and now numbers 36,000 volumes in all departments of literature.

It is well supplied with works of biography, history, and travels, and possesses many valuable and uncommon books relating to American history. It has also a fine collection of English literature of the seventeenth and eighteenth centuries. Being a circulating library, it includes, of course, a large proportion of works of fiction.

Its pamphlet collection now numbers about 12,000, being particularly full in pamphlets relating to the State and city, and in publications, official and others, of the late Confederate States.

The reading-room is supplied with the leading American and foreign periodicals.

The rooms, at the corner of Saratoga and St. Paul Streets, are open daily from 9 A. M. to 10 P. M.

The price of the stock is five dollars per share, with yearly dues of three dollars. Non-stockholders pay a subscription of five dollars per year; three dollars six months, two dollars three months.

Library of the Maryland Institute.

Mr. A. F. Lusby, *Librarian.*

From the foundation of this institution, in 1848, the library has been one of its leading features. The first design was that it should be especially rich in books of reference and instruction bearing upon the mechanic arts, as it was to promote those that the Institute had been founded. Before long, however, it was plainly seen that to attract subscriptions a more miscellaneous and popular character must be given to the collection; and consequently at present more than four-fifths of its contents are works of fiction.

This library now contains about 19,000 volumes and circulates about 800 weekly. Its use is limited to members of the Institute, the membership subscription being five dollars yearly for men, and three for women and children.

Library of the Medical and Chirurgical Faculty.

Dr. J. D. Fiske, *Librarian.*

The association to which this library belongs, and with which it is co-existent, was founded in 1799. It is supported by the annual appropriation of about one-third of the membership dues. The bound volumes number about 3000, but most of the expenditure is for periodicals, of which thirty-three are taken. The collection of books is gradually increasing, chiefly by gift. Members are entitled to take out books for a fortnight, with privilege of renewal. The library is open, at 122 West Fayette Street, from 6 A. M. to 9 P. M.

South Baltimore Mechanics' Library.

Mr. W. S. Harrington, *Librarian.*

In the year 1859, when the volunteer fire-companies of the city were superseded by the present organization, a number of citizens of South Baltimore, thinking a circulating library in that section of the city a desirable thing, especially for mechanics and their families, formed themselves into a library association, and fitted up for their purpose a disused engine-house at No. 158 Montgomery Street.

This library has about 2000 volumes, with an average daily circulation of twenty. It is open every evening, except Saturdays, from 7 to 10. The annual subscription is one dollar, and adult subscribers have a voice and vote in the administration. The present membership is about 150, and the library, according to the librarian's account, barely holds its own. It is a pity that so praiseworthy an undertaking, which should be specially serviceable in a part of the city so far from the other public libraries, receives so little encouragement.

Library of the Independent Order of Odd Fellows.

Mr. A. T. King, *Librarian.*

This library was founded in 1840, and is supported by *pro-rata* contributions from the funds of the various lodges and encampments. It is a library of circulation as well as reference, and is open to all members of the Order in the city. It contains about 20,500 volumes, of which 8000 are German; and about one-fourth of the whole are works of fiction.

The readers of this library average 75 daily, and it circulates about 400 volumes a week. The hours of admission are from 7 to 10 P. M. from Monday to Friday.

Concordia Club Library.

Mr. G. Schwegendeck, *Librarian.*

The Concordia, a German club, was founded in 1850, and a library for the use of its members was included in its organization. This library contains about 3500 volumes, chiefly German works. A number of leading journals and periodicals, both German and American, are taken. The membership-subscription is thirty dollars yearly, including the use of the library and the right to take out books. The library is open from 1 to 2.30 P. M. Tuesdays and Fridays, in the Concordia building, 10 S. Eutaw Street.

Summary of Volumes in Baltimore Libraries.

There are accessible, under various conditions, to readers in Baltimore, about 197,450 volumes, located as follows:

Peabody Institute Library.	vols.	67,850
Johns Hopkins University Library.	"	8,600
Maryland Historical Society Library.	"	17,000
Mercantile Library,	"	48,000
Baltimore Bar Library.	"	8,000
Medical and Chirurgical Faculty Library,	"	3,000
Maryland Institute Library,	"	19,000
Odd-Fellows' Library,	"	20,500
Concordia Club Library.	"	3,500
South Baltimore Mechanics' Library,	"	2,000
	Total,	197,450

More than 600 different periodicals are also received at the libraries above-mentioned.

There are, besides those above enumerated, a number of minor libraries attached to schools, churches, and other institutions, or maintained by subscription in various parts of the city.

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

Published here.

American Journal of Philology. Edited by PROFESSOR GILDERSLEEVE. *Vol. I. No.* 1. *February*, 1880.

Article I.—Δίκαι ἀπὸ συμβόλων *and* δίκαι συμβόλαιαι. By W. W. GOODWIN, *Professor of Greek in Harvard University.*

In this article Professor Goodwin discusses three points:

First, to what extent were the allies of Athens required to bring their lawsuits to Athens for trial?

Secondly, what were the δίκαι ἀπὸ συμβόλων, apart from any supposed allusion to them in Thucydides?

Thirdly, are the συμβόλαιαι δίκαι of Thucydides, I. 77, identical with the ἀίκαι ἀπὸ συμβόλων, as has been supposed on the basis of a quotation from Aristotle in Bekker's Anecdota, p. 436, 1?

1. As to the extent of the Athenian jurisdiction over the subject allies, Prof. Goodwin thinks that so far as it applied to civil suits between citizens of different states within the alliance, it was hardly a piece of oppression, as it secured an even administration of justice throughout the Athenian dominions. Nor could it be thought oppressive that Athens should insist on having all suits between Athenians and citizens of the subject states tried at Athens. The real hardship was felt when the subject allies were obliged to bring to Athens all the civil suits between citizens of the same state. Still there must have been some local jurisdiction, even if limited to cases which involved only small amounts of money. Indeed it may be inferred from Antiphon, 5, 47, that less important criminal trials were not carried to Athens. The use of γραψάμενος and γραφή in the famous trial of Hegemon, Athen. X, 407 C., shows that it was a public suit; but the suits in Ar. Av., 1420–1460, are civil, not criminal, as shown by the use of ἐγκεκληκώς (v. 1455).

2. As to the δίκαι ἀπὸ συμβόλων, σύμβολα means treaties which independent states make with each other to define the conditions under which citizens of either may sue or be sued in the courts of the other. See Harpocr. *s. v.* and [Dem.] 7, 9, which Prof. Goodwin interprets in accordance with the views of Reiske, Jakobs and others, as is set forth in a note on p. 12. When foreigners were defeated before an Athenian court in a suit with an Athenian, an appeal could be had to a πόλις ἔκκλητος, "a city of appeal," not to the courts of the country of the defeated party, as has been supposed. In the time of Philip, however, Athens seems to have exercised the right of the stronger, and to have reserved to herself the right of "confirming" all decisions of foreign courts which affected her own citizens. Where there was a πόλις ἔκκλητος provided in the σύμβολα, the κύρωσις reserved by Athens may have been merely the process by which a judgment could be carried on appeal to the foreign court; when there was no such court, it gave Athens the right to *veto*. This construction depends, however, on the interpretation of the oration De Halonneso, *l. c.*, a passage which is discussed at length.

3. The δικαι συμβόλαιαι of Thuc. I. 77 are not identical with the δίκαι ἀπὸ συμβόλων, as has been maintained by Curtius and others, and in support of the view taken by Boeckh and Grote that δίκαι συμβόλαιαι are "suits relating to contracts" or "business suits," Prof. Goodwin cites two passages in Aristotle's Politics never yet adduced, which he considers conclusive — III. 1, 10 and II. 5, 11. These results are now applied to the passage of Thucydides under discussion — 1. 76, 77.

Article II.—*Two German Scholars on one of Goethe's Masquerades* By FRANKLIN CARTER, *Professor of German in Yale College.*

An elaborate comparison and balancing of the views of Wilmanns and Scherer as to the originals of the characters represented in "*Das Jahrmarktsfest zu Plundersweilern.*"

In the course of this paper the relations of Goethe to Leuchsenring, the Mercks, the La Roches, Herder and Wieland are discussed, and so what were else a disconnected farce is filled, even for us, "with the brightness and vigor of a great mind at play." "What" then "must have been the delight with which the initiated few noticed the sharpness of the hits and discerned the skill with which they themselves and other well known personages were woven into a somewhat organic whole!"

Prof. Carter closes his article with the expression of the hope that "by and by other and nobler creations of Goethe, as yet unknown in their genesis will disclose the roots of their being." "We shall then admire the characters no less, but the master still more, as it becomes more plain that nothing in human nature of sweetness, or grandeur, or ugliness escaped his searching eye; that the most diverse elements were happily united in his poetical fabrics; that his characters are so near and dear, because he ruled nature and transmuted the sweets of her every flower into honey for the cold, dull winters of a more prosaic time."

Article III. *Geddes' Problem of the Homeric Poems.* By L. R. PACKARD, *Professor of Greek in Yale College.*

Geddes makes almost the same division of the Iliad that Grote does, and the arguments in support of his theory belong to the same general class. Still in the form which it takes and the concessions it demands, it is virtually a new theory. Grote rejected from his original Achilleid, Books II–VII, IX, X, and possibly also XXIII and XXIV. In addition to these, Geddes rejects the speech of Nestor in XI (670–806), the description of the shield in XVIII, and the last hundred lines or so, all that follow the death of Hektor, in XXII. He goes through the poems with a series of tests, and with each one finds these portions of the Iliad differing from the rest and agreeing with the Odyssey. All these parts of the Iliad, then, he regards as an addition made by the same poet who wrote the Odyssey, and so he calls them the Ulyssean books, the rest being the Achillean. The poet of the Achillean books knows Thessaly and the adjacent country; the poet of the Ulyssean books and of the Odyssey seems to have lived in Asia Minor. The one favors Achilles, the representative of the old Aeolo-Dorian stock, the other Odysseus and the heroes of southern Greece. To his theory Professor Geddes applies the test of character-drawing, theology, psychology and ethics, manners and customs. This Professor Packard considers the most valuable part of the book. "It is full of interesting observations and nice distinctions, and bears witness to minute and laborious study on the part of the author. Original is the observation that the horse is preeminently the favorite animal of the Achillean books and the dog is disparaged, while in the Ulyssean books and the Odyssey this relation of the two animals is reversed."

Professor Packard then criticises the method followed by Mr. Geddes:

1. It assumes the connection of the Ulyssean portions of the Iliad with one another and with the Odyssey in time and authorship. His data prove at the best that the Achillean books proceeded from one stage of society and one locality, and the Ulyssean books with the Odyssey from a later stage of society and a different locality. He assumes the unity of the Odyssey and ignores wholly the work of Hennings, Kirchhoff and others.

2. In many instances Professor Geddes seems to find his evidence only in some single book or passage, or in some two or three only, and then to set it down as a feature of the Achillean or Ulyssean portion as a whole.

3. Professor Geddes ignores too much the influence that the poet's subject has upon his use of words and upon his representations of life and character — an influence which has long been recognized as the cause of part of the manifest difference between the Iliad and the Odyssey.

4. Professor Geddes' theory does not take account of the inconsistencies that run through the whole texture of each of the poems. It does not seem to supersede the "*Kleinliedertheorie*" in any of its forms, but rather to be a possible addition to it, applying to a later stage of the growth of the poems.

Article IV.—*Encroachments of* μή *on* οὐ *in later Greek.* BY B. L. GILDERSLEEVE, *Professor of Greek in the Johns Hopkins University.*

In this article Professor Gildersleeve has endeavored to trace the gradual extension of the use of μή into the territory occupied mainly by οὐ in the classic time, and has endeavored to show that the later use is not purely solecistic, but a genuine germinal growth out of the old time, although it is not to be denied that it finally degenerated into palpable misuse. To show this process Prof. Gildersleeve has selected the usage of Lucian, and has traced the development of the later use under the various heads of 1. μή with *oratio obliqua* infinitive, 2. ὅτι μή, 3. Causal μή, 4. Relative μή, 5. Participial μή.

Notes.—PROF. THOS. DAVIDSON shows from Bekker's Anecdota Graeca, p. 262, that there was a Dionysion at Marathon.

A. C. MERRIAM, of Columbia College, interprets *ἀίζηλον*, Il. II. 318, as "invisible," and, with the help of Od. XIII. 169, meets Ameis's desire for the identity of "invisibility" with "transformation."

A. S. COOK, of Johns Hopkins University, discusses the origin of the word *weasand*, which he identifies with the disputed word *weisen* in Konrad's *Otto mit dem Barte*, and after giving instances of the omission of *h* before *l* and *r*, produces proof that *h* was dropped before *w* also, and that *weasand* is thus in all likelihood connected with *wheeze*.

In *Varia*, PROF. THOMAS DAVIDSON emends a fragment of Korinna, a passage in Aristotle's Metaphysics, and fills a lacuna in Pausanias.

Reviews and Book Notices.— PROF. C. R. LANMAN, of the Johns Hopkins University, calls attention to the appearance of Prof. Whitney's Sanskrit Grammar, and gives a brief characteristic of this most important work, with an implied promise of a detailed review.

PROF. M. W. HUMPHREYS, of Vanderbilt University, says of Clough's Study of the Hexameter of Virgil and Study of the Principal Latin Rhythms other than the Hexameter, that "the sole merit of these essays is that they propose to do away with the too prevalent system of sacrificing the sense to the scansion."

PROF. THOMAS DAVIDSON says of Vincent and Dickson's Handbook to Modern Greek that "this is the best work on modern Greek that has hitherto appeared in the English language," but after all "this is not very high praise." "This little work cannot fail to be of great use to persons about to visit Greece or to take up the study of modern Greek," but "the authors are capable of writing a much better book than they have written."

The editor, in noticing a Dissertation on the Interpolations of the Alcestis and Hippolytus of Euripides, by Dr. J. H. Wheeler, late Fellow of the Johns Hopkins University, while giving no assent to Dr. Wheeler's positions, accords to him an unusual acquaintance with Euripides, learning, insight, ingenuity and independence.

Tyler's Lyric Poets is noticed unfavorably.

Hewett's Frisian Language and Literature favorably.

The remainder of the first number is taken up by reports on the *Revue de Philologie*, 1877–79, by PROF. M. W. HUMPHREYS, of Vanderbilt University; on the *Anglia* by PROF. J. M. GARNETT, Principal of St. John's College, Annapolis; on the *Revue Archéologique*, by A. D. SAVAGE, of the Metropolitan Museum of Art, N. Y.; on *Hermes*, by E. G. SIHLER, of New York; on the *Athenaion*, by PROF. THOMAS DAVIDSON; on Fleckeisen's *Jahrbücher*, by E. G. SIHLER; on *Mnemosyne*, by Prof. C. D. MORRIS, of Johns Hopkins University; and on *Romania*, by SAMUEL GARNER, of Johns Hopkins University. To these is appended a List of Periodicals at the command of the Journal of Philology, and the number closes with a record of recent philological publications, American, British, French and German.

American Chemical Journal. Edited by PROF. REMSEN.

Vol. I. *No.* 6. *February*, 1880.

Article I.—*A Method for the Proximate Analysis of Plants.* By H. B. PARSONS.

In studying the processes of plant life, it is important to be able to determine, as accurately as possible, the chemical composition of the various parts of the plant at different stages of its growth. It is very difficult at present to make such determinations, for the material to be dealt with is extremely complex, and the methods of analysis applicable for the purpose are very imperfect. The author has attempted to bring together in one scheme all the best methods now known for the analysis of plants. He says: "If the present scheme shall serve merely as an example, to be improved upon as discoveries multiply, it will at least have served to stimulate to the more thorough study, this side the Atlantic, of a much neglected, yet very important, branch of analysis."

Article II.—*On the Estimation of Phosphoric Acid as Magnesic Pyrophosphate.* By F. A. GOOCH.

In the course of the elaborate investigations on the complex inorganic acids by Dr. Wolcott Gibbs, numerous accurate determinations of the phosphoric oxide of phosphotungstates and phosphomolybdates became necessary. This led to a revision of much of what had been previously published concerning the determination of phosphoric acid as ammonio-magnesic phosphate and estimation as magnesic pyrophosphate. The present paper contains an account of a long series of careful experiments undertaken by the author, the [illegible] are of permanent value to analytical chemistry. At r a summary of the results is given, and this serves the best set of rules for the accurate determination nder the conditions usually met with.

Article III.—*Laboratory Notes.* By ARTHUR MICHAEL.

1.—*On Mono-Ethylphthalate.* This substance was obtained by treating phthalic anhydride with absolute alcohol, the reaction being similar to that used for the preparation of mono-ethylsuccinate by the action of alcohol on succinic anhydride. The product has acid properties, yielding salts of which the barium and silver salts were prepared and analyzed. Treated with phosphorus trichloride, the acid does not yield the corresponding chloride, but phthalic anhydride.

2.—*On a new Formation of Ethyl-Mustard Oil.* A small quantity of ethyl-mustard oil was obtained by treating ethyl iodide with mercuric sulphocyanate. This reaction is similar to those involved in the formation of carbamines from cyanides, and of nitro-compounds from nitrites. The two latter reactions, however, are particularly easily effected through the silver salts, whereas, in the case of the mustard-oil, the silver salt of sulphocyanic acid does not answer the purpose.

3.—*On the Preparation of Methyl Aldehyde.* The method recommended which, according to the author, yields almost the theoretical quantity of an aqueous solution of methyl aldehyde, consists in treating monochlormethyl acetate with water. The reaction is expressed thus:

$$CH_2Cl - O - OC - CH_3 + H_2O = CH_2O + C_2H_4O_2 + HCl.$$

4.—*On the "Migration of Atoms in the Molecule" and Reimer's Chloroform-Aldehyde Reaction.*

This paper presents a discussion of the subject described in the title. No new facts are brought forward, but some novel views are contained in the paper which may serve to throw light on the subject.

Article IV.—*On the Oxidation of Substitution Products of Aromatic Hydrocarbons:—On the Oxidation of Orthotoluenesulphamide.* By IRA REMSEN and C. FAHLBERG.

This is the fourth of a series of papers describing the results reached in the investigations on the subject described in the general title here given. The object in view is the determination of the influence exerted by the position of the substituting groups upon the oxidation phenomena. There are two products formed when orthotoluenesulphamide is oxidized with potassium permanganate, viz: *benzoic sulphinide*, $C_6H_4\left<\begin{matrix}CO\\SO_2NH\end{matrix}\right]$; and *orthosulphobenzoic acid*, $C_6H_4\left<\begin{matrix}CO_2H\\SO_3H\end{matrix}\right.$. The former of these is the sweetest substance known. In its chemical structure there is a certain similarity to the structure of the compounds of the indigo group. Treated with bases it yields salts of *orthosulphaminebenzoic acid*, $C_6H_4\left<\begin{matrix}CO_2H\\SO_2NH_2\end{matrix}\right.$. Benzoic sulphamide can be transformed into orthosulphobenzoic acid by heating it with water to 150°; and the latter can be easily reconverted into the former by treating it successively with phosphorus pentachloride, ammonia and hydrochloric acid.

Article V.—*On an Unusual Case of Electrolysis.* By J. W. MALLET.

The plates of a galvanic battery of Smee's construction having accidentally fallen into the sulphuric acid contained in the cells, they remained unnoticed for two or three days. On examining the plates it was found that one of the sheets of thin platinized silver-foil was very considerably thickened by a layer of metallic zinc. In this particular cell the acid had doubtless first become completely converted into zinc sulphate, in which subsequently, the circuit being closed by the loose contact of the terminal wires, the chemical action of the battery had transferred itself from hydrogen sulphate to zinc sulphate, and metallic zinc was electrolytically thrown down from the strong solution of the salt.

Brief Review of the most important Changes in the Industrial Applications of Chemistry within the last few years, (Continued). This is a continuation of Professor Mallet's report, which was begun in the first number of the Journal. In this instalment, under the head of *Minor Chemical Manufactures*, there are summarized the latest developments in connection with the manufacture of iodine, potassium iodide, bromine, phosphorus, carbon disulphide, arsenic acid, oxygen gas, methyl alcohol, methyl chloride, ethyl alcohol, ether and chloroform, chloral hydrate, glycerine, benzoic acid, salicylic acid, the alkaloids, &c. Under the head *Mechanical Applications of Chemical Manufactures in General*, a number of recent improvements are briefly considered.

The remaining portion of this number is made up of *Notes*, under which appear *A new Form of Absorption-Apparatus for use in Estimating Ammonia*, by F. A. Gooch; *Glucose*, by Péligot; *New Metals; On Coto Bark and its Constituents; Transformation of Piperidine into Pyridine.*

Finally there is a list of *Recent Publications relating to Chemistry.*

American Journal of Mathematics. Edited by PROFESSOR SYLVESTER and DR. W. E. STORY. *Vol. II. No.* 4.

Article I.—Tables of the Generating Functions and Ground-Forms for Simultaneous Binary Quantics of the First Four Orders, taken two and two together. Remarks on the Preceding Tables. By J. J. SYLVESTER.

The title of this paper sufficiently explains its contents. The generating functions, besides leading to the fundamental in- and covariants, afford the means of determining all the equations of a given order and degree that can be formed between them. The tables of fundamental forms contain the results previously arrived at by the German invariantists, but corrected of errors which their enumeration contains, as regards cubo-cubic, cubo-quartic and quarto-quartic systems.

Article II.—A New General Method of Interpolation.—By EMORY MCCLINTOCK.

This is an exposition of a new method of interpolation, "apparently both easier to prove and easier to work" than the methods of Lagrange and Newton, for the general case where the values of the argument for which the function is given do not form an arithmetical progression. The formula is the same as in Newton's method, the difference lying in the manner of obtaining the coefficients. "The amount of labor required in both cases is the same, but the strain on the attention is lessened by employing a more symmetrical formula. The work done is more mechanical, and therefore easier." An example is worked out by the new method.

To this paper is appended a *Note on the Demonstration of Certain Formulae for Interpolation*, relating to two developments attributed to Stirling, and hitherto demonstrated only by the method of generating functions.

Article III.—A Certain Class of Cubic Surfaces Treated by Quaternions. By A. B. CHACE.

At the close of this paper the author says, "In the preceding pages I have attempted to classify very briefly some of the various families of the central cubic surfaces, and have suggested only just enough of their properties to enable one partially to conceive of their several shapes, using only the more simple of the quaternion methods."

Article IV.—On the Ghosts in Rutherfurd's Diffraction-Spectra. By C. S. PEIRCE.

Deduction of formulae to determine the positions of the so-called "ghosts," or repetitions of the principal spectrum, due to a periodic inequality in the ruling of Rutherfurd's diffraction-plates. Appended is a comparison of the theory with observations.

Article V.—On a Theorem for Expanding Functions of Functions. By EMORY MCCLINTOCK.

An extension of "Salmon's theorem," so-called, to the case of non-algebraic functions. A foot-note by Professor Sylvester calls attention to the fact that this name was assigned by him to the theorem, without consulting Dr. Salmon, in error, and that it is probably due to Chev. Faà de Bruno.

Article VI.—Preliminary Notes on Mr. Hall's Recent Discovery. By H. A. ROWLAND.

A preliminary approximate application of the results of Mr. Hall's discovery (announced in the preceding number of the Journal) to Maxwell's theory of light, and especially to the phenomenon of the rotation of the plane of polarization in a magnetic field.

Article VII.—On Certain Ternary Cubic-Form Equations. By J. J. SYLVESTER.

Chapter 1.—On the resolution of numbers into the sum or difference of two cubes.

Section 1, containing the "Proem," appeared in the preceding number and contains a summary of some of the principal results to be established in this chapter.

In the present number is published an *Excursus on the Divisors of Cyclotomic Functions*, under 3 titles.

The *First Title* gives the complete theory of the divisors of cyclotomics of the first species, *i. e.* of the functions which contain the primitive kth roots of unity, k being any given number, called the index of the function.

The prime divisors are separated into two classes, extrinsic, which do not divide the index, and intrinsic, which divide the function and its index. The former are shown to be all primes of the form $mk \pm 1$, and it is proved that any power of such a divisor is a divisor. On the other hand, except when it is of the form $\frac{p-1}{m}p^j$, no intrinsic divisor exists; but when k is of that form, p, but no power of p, is a divisor of the cyclotomic.

Under the *Second Title* the theory of cyclotomics of the second species (conjugate class) is fully developed. Such functions have for their roots $\rho + \frac{1}{\rho}$, where ρ is a prime kth root of unity. The same division into extrinsic and intrinsic divisors is made as in the former case, and, as in that case, every power of an extrinsic prime divisor is itself a divisor, but no higher than the first power of an intrinsic prime divisor, when any such exists, is a divisor.

Every prime extrinsic divisor is proved to be of the form $mk + 1$. The condition of the existence of an intrinsic divisor is shown to be conditional on k being of the form $\frac{p \pm 1}{m}p^j$ (p being a prime), and when that condition is fulfilled p is an intrinsic divisor.

Under the *Third Title*, cyclotomic functions of non-conjugate classes of the second species and of any class of the higher species (functions, that is to say, whose roots are linear combinations of any assigned number of the kth roots of unity) are discussed, and examples furnished of the applicability to them of similar laws to those which govern the two sorts previously treated; but this portion of the theory is not reduced to apodictic demonstration, nor is the law of the intrinsic divisors worked out.

This very large theory took its rise in the necessity of proving that no prime except of the form $18\,m \pm 1$ could be contained as a divisor in the function $x^3 + 3xy^2 + y^3$ which is a cyclo-quantic of the second species (conjugate class) to the index 9.

With the aid of this fact, in *Section Two* (*Title One*) it is demonstrated that certain numbers and classes of numbers (containing no other prime factors except 2, 3 or of the form $18\,n + 5$ or $18\,n + 11$) are irresoluble into the sum or difference of two cubes. Of the four most general classes contained in this theorem, certain particular cases only (discovered by the Abbé Pepin) were previously known.

In that part of the article called *Note to Proem* the author, in order to explain a seeming contradiction, has occasion to consider a triangle at the same time in- and ex-scribed to a certain special cubic, and is thereby led to consider the theory of triangles in- and ex-scribable to a cubic curve in general. He proves the existence of 24 such, (only a certain number of which are real), and explains their relation to the nine points of inflexion. The number of in- and ex-scribed polygons of any given number of sides is also fully determined.

In another part of the note he gives an elementary method of determining the conditions of 2 and 3 being cubic residues to a given number, the result being referred to in the *Proem* and required for ulterior use in the memoir.

A similar method might be employed and would be the briefest for determining the condition of —2 or 2 being a quadratic residue.

Article VIII.—A Quincuncial Projection of the Sphere. (With a Plate.) By C. S. PEIRCE.

A new projection of the sphere, useful for cartographic purposes. It possesses the following properties:

1. The whole sphere is represented on repeating squares.
2. The part where the exaggeration of scale amounts to double that at the centre is only 9 per cent. of the area of the sphere, against 13 per cent. for Mercator's projection, and 50 per cent. for the stereographic.
3. The angles are exactly preserved.
4. The curvature of lines representing great circles is, in every case, very slight, over the greater part of their length.

Article IX. Notes on the Gem Puzzle. By W. W. JOHNSON and W. E. STORY.

In these notes, which, it is hoped, will be intelligible even to non-mathematical readers, are proved the impossibility of solution of the puzzle in certain cases, and the possibility of solution in all other cases; a method being given for the solution when one is possible. The results apply to a square or rectangular board with any number of rows, any number of columns, and a number of counters one less than that of squares on the board. It is also proved that, in the ordinary form of the puzzle, *i. e.* with a square board of 16 spaces with 15 counters, when a solution is possible with 1 in a given corner, it is also possible with the 1 in the opposite, but not in either adjacent corner; while on a square board of 25 spaces with 24 counters, if a solution is possible with the 1 in a given corner, it is possible with the 1 in either corner, and therefore, if not possible with the 1 in a given corner, it is not possible at all.

Studies from the Biological Laboratory. Edited by Professor Martin. *Vol. I. Part 2.* 1879–80.

A considerable portion of the results of the original investigations carried on in connection with the Biological Department during the past academic year (1878–79) are here collected: the remainder, containing the results, in original work, of the Chesapeake Summer Laboratory, will be published immediately.

In Part 2 of the Studies from the Laboratory there are seven papers, some reprinted from the Journal of Physiology, in which they first appeared, and others now published for the first time.

I. The first article, by Prof. Martin and Mr. Hartwell, settles a point long disputed in physiology, viz: whether the internal intercostal muscles are inspiratory or expiratory.

Lying between the ribs and covered by the external intercostals the function of these muscles is by no means easy to decide. When one contracts it will approximate the two ribs to which it is fixed, but whether this approximation is attained by raising the lower (inspiration), or depressing the upper rib (expiration), is not easy to get at. It will depend on the relative fixity of the two, and this in turn upon the relative force with which a large number of other muscles attached to the ribs are at that moment contracted. Hence, argument from the relative stability of the ribs in the prepared skeleton, or from observation of the results of contraction of these muscles when others in their neighborhood have been removed, or when these others are not working as they normally do in breathing, is quite inconclusive, and in fact every possible view of the use of the internal intercostals has been put forward and sustained by observations defective in some one or more of the above respects. The authors, despairing of exposing the muscles and at the same time preserving the normal statical condition of the chest wall, went to work by another method. The breathing muscles are all co-ordinated from a nerve centre in the medulla: all the inspiratory work together and all the expiratory; and the method adopted was to take an undoubted inspiratory muscle (the diaphragm) and see if a bit of intercostal muscle isolated from the rest of the body except for its nerve, which placed it in connection with the spinal cord, contracted together or alternately with the diaphragm, the movements of both being recorded on the same vertical line on a travelling sheet of paper. They found that when the animal breathed the muscles in question contracted at the same time as the diaphragm and were accordingly undoubtedly muscles of inspiration.

II. The second paper, by Dr. Ott, deals with some points in the physiology of the spinal cord, especially with the localization of the sweat centres in it for the posterior limbs and of the centres which bring about vascular dilatation in the same regions.

The paths taken in the cord by certain sets of nerve fibres are also discussed. Goltz of Strasburg some time ago found that when the cord was divided in the cervical or dorsal region certain sphincter muscles no longer kept up their natural state of tonic contraction, but exhibited rhythmic contractions alternating with relaxations. The causation of this phenomenon is still obscure. Dr. Ott finds it in certain other sphincters, and that the fibres controlling the rhythm and converting it into a steady contraction run in the lateral columns of the spinal cord. The centre in which they originate seems to be in optic thalami.

III. Dr. Sewall contributes the third paper, which deals with some of the phenomena of muscular contraction, his experiments being carried on by means of the splendid and unique myograph possessed by the University.

When a single electric shock (stimulus) is sent through a muscle or its nerve, the muscle responds with a simple contraction or a "twitch." When a number of shocks are sent in at intervals of not less than one-tenth of a second the muscle remains in a state of steady, permanent contraction (a compound contraction), which is also greater in extent than the twitch; in other words, a number of simple contractions are summated and also fused together. Dr. Sewall endeavored to find what was the shortest interval between two electric stimuli which would give rise to a summated contraction: he finds it is one-thousandth of a second for a frog's muscle; that the greatest summation es place when the shocks succeed one another at intervals of 0.048 onds, and that complete fusion of the twitches due to two shocks, so he compound contraction lost all trace of its complex character and ecorded as one unbroken curve, took place when the stimuli were 0.026 seconds apart. Important observations were also made as to the influence of one stimulation of a muscle upon its behavior when subjected subsequently to another; and it was shown that this element, the time between successive stimuli acting upon it, is an extremely important one in determining how much work can be got out of a given muscle.

IV. The fourth paper, by Dr. Christian Sihler, deals with heat dyspnœa.

When an animal's temperature is raised it breathes faster and more laboriously, and the cause of this has not only a physiological interest as tending to throw light on the theory of respiration, but a pathological one with reference to the quickened respiration of febrile diseased conditions. The view previously held, based on experiments carried out by Goldstein in Fick's Laboratory at Wurzburg, has been that the warmer blood circulating in certain parts of the brain excited the breathing nerve centres there to greater activity. Dr. Sihler shows that Goldstein's experiments are inconclusive and his deductions erroneous: the phenomenon being really due to the stimulation of cutaneous sensory nerves by the heat, and these in turn reflexly exciting the respiratory centre.

The fifth paper, by Prof. Martin, describes a form of time-recording pen for use in physiological experiments.

The sixth and seventh papers are morphological.

VI. The sixth paper, by Dr. Brooks, describes the early stages in the development of certain fresh water snails.

This is an important contribution to this subject, which is at present one of the most disputed in embryology, and one of the most interesting as being a main position in the battle-ground on which the opponents and supporters of Hæckel's gastrula theory meet. Dr. Brooks's paper deals mainly with the development of the alimentary canal, and almost simultaneously with it two papers appeared in Europe on the same subject and have since reached this country. In them Dr. Brooks's observations are in the main confirmed.

VII. The final article, by Dr. Clarke, describes the external changes gone through by the embryoes of one of the tailed Amphibians (*Amblystoma punctatum*) from the time the eggs are laid until the animal gains its limbs, loses its gills and acquires its adult form.

The paper is preliminary to one on the internal phenomena taking place during the same course of development.

Vol. I., *Part* 4.—1879–80, will appear immediately.

It contains two papers by Dr. Brooks embracing the scientific results of his work at the Seaside Laboratory of the University during the past summer.

The first paper, on the Development of the American Oyster, is practically the first real contribution to our knowledge of this subject and is illustrated by ten plates. It also appears in the Report of the Maryland Fish Commission.

The second paper is a discussion on the significance of the presence and absence of a food yolk in the eggs of different Molluscs.

Vol. I. of the Studies from the Biological Laboratory is now complete, and contains over five hundred pages and forty plates, as follows:

No. I. 1878–79. 91 pp. 4 plates.
No. II. 1879–80. 125 pp. 12 plates.
No. III. (Originally published as Scientific Results of the Chesapeake Zoölogical Laboratory, 1878.) 170 pp. 13 plates.
No. IV. In press as above stated.

Separate copies of Parts 2 and 4 can be obtained, at $1 each; the whole volume will be forwarded on receipt of $3.50.

In future the Studies from the Biological Laboratory will appear under the joint editorship of Prof. Martin and Dr. Brooks; the former taking charge of the physiological and the latter of the morphological papers. The parts, which will contain about 120 pages, will be supplied separately at $1.50, and the volume of four parts at $5. The editors are desirous of making arrangements for exchange with other serial scientific publications.

MEETINGS OF UNIVERSITY SOCIETIES.

Scientific Association.

March 3, 1880.

(1) PROFESSOR J. WILLARD GIBBS, of Yale College, Lecturer on Mechanics, read a paper "On Notations for Vectors."

(2) PROFESSOR ROWLAND, presented a communication entitled, "An Explanation of Magnetic Attraction and Repulsion by the Motion of a Perfect Fluid."

A large number of facts seem to show that magnetism is a rotary phenomenon of some kind, and this has been recognized for some time by scientists. Sir Wm. Thomson has shown that the magnetic rotation of the plane of polarization of light can only be explained by a real rotation of something within the magnetic field. At a late meeting of the Association, it was pointed out that Mr. Hall's recent discovery also indicated a rotation around the lines of magnetic force.

The present paper considers the magnetic action of electric currents in an indefinitely large and homogeneous conducting medium, and shows that there can be no magnetic action in such a medium unless the electric currents formed *closed* circuits, or, in other words, unless there is a rotation of electricity. Treating the relations of the electric currents and magnetism by means of vector potentials, the magnetic force is expressed by the same equations as those by which we obtain the velocity of rotation of a fluid in Helmholtz's theory of vortices. If, then, we conceive of a perfect fluid with a velocity at every point equal to, and in the same direction as, the vector potential, then the vortex filaments in the fluid will be the lines of magnetic force and the *relative motion* of each particle with respect to those around it will be the electric current. The vortex filaments will tend to contract longitudinally and expand laterally, which would account for all magnetic attractions and repulsions. Maxwell published a somewhat similar theory, but he used an "ether" of very artificial construction and not a perfect fluid, because he could not think of any manner of producing vortices in a perfect fluid. This difficulty is obviated by supposing that the electro-motive force rotates the fluid at the point where it acts, and that the vortices so produced move forward to allow the electro-motive force to act on fresh fluid; thus the whole space will be filled with vortices by a rotatory action at only one point of the fluid. This theory of magnetic action is only considered as one step in the right direction, seeing that electrostatic action remains unexplained.

Philological Association.

March 5, 1880.

(1) The principal paper was by PROFESSOR C. D. MORRIS, on Xenophon's Oeconomicus.

This paper gave an account of an edition of Xenophon's Oeconomicus put forth by Karl Lincke (*Jena*, 1879). It was shown that the passages removed by him from the traditional text, amount to considerably more than a quarter of the whole. The reason which chiefly induced him to make such large excisions appeared to be an impression that the discourse of Socrates with Ischomachus, which occupies the latter portion of the book, is to be regarded as the fulfilment by Socrates of his promise to help his friend Critobulus in his efforts to improve his estate. It was shown that no such conclusion is justified by the words of the dialogue. The chief objections alleged by Lincke against the passages he expels from the text were then stated; and it was shown that neither on grounds of consistency and symmetry, nor on those of phraseology and style, is there any adequate reason for subjecting the text to such violent and arbitrary mutilation. Passages were cited from August Boeckh and Leonhard Spengel in condemnation of this tendency to ἀθέτησις, which was regarded as far too prevalent among scholars of a certain type.

(2) MR. S. GARNER read a paper on the So-called "Subjonctif Dubitatif," *je ne sache pas*, in the principal clause.

That this single verb should allow a subjunctive construction in this one form can be justified by no principle of French syntax. It was proposed to take it as an indicative coming directly from *sapio*. This derivation was supported by the analogy of *proche* from *propius*, and *reproche* from *repropium*. So the *ch* of Provençal *sapcha*, *sabcha*, represents the palatal *i* of *sapiam*.

It can hardly be doubted that the imperatives *sache*, *sachons* and *sachez* are old indicative forms. This consideration, coupled with the fact that there are two present participles, *sachant* and *savant*, makes it highly probable that *savoir* was one of the numerous verbs of Old French which had two inflections for the present indicative, the older coming directly from the Latin, and the younger being of purely French formation.

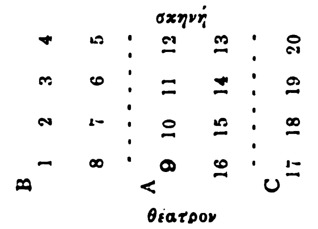
(3) PROFESSOR COOK read a Note on Hamlet i. 1. 63.

This paper called attention to a misinterpretation of the passage, supported by the authority of several German commentators and repeated by Schmidt in his Shakespeare-Lexicon, under the word *sledded*. It arises from reading "pole-axe" for "Polacks." Schmidt's assertion that "smite" cannot well mean "beat" or "defeat," was refuted by the production of several Biblical examples containing "smite" in that sense.

(4) MR. F. G. ALLINSON proposed a Redistribution of the Parodos of the Vespae.

The general truth of Arnoldt's arrangement of the Choruses in Aristophanes (*Die Chorpartien bei Aristophanes, scenisch erläutert von Dr. R. Arnoldt, Leipzig*, 1873) seems certain; but a redistribution of details in the Parodos of the Vespae is desirable, if not imperative. The following arrangement, as well as that of Arnoldt, observes the natural demarcations of the changes in metre, corresponding to the changes in the parts. A, B, and C represent the link-boys; 9, the Coryphaeus.

I. Verses 239-247: eight choreutae (iambic tetrameter catalectic).
Interlude first, v. 247-257: Coryphaeus and boy A.
II. Verses 258-272: eight choreutae (syncopated tetrameter).
III. Verses 273-290: eight choreutae (dactylo epitrites).



The two choreutae introduced by Arnoldt in the interlude, v. 247-257, and the six choreutae of his "part iv." may then be introduced as follows: v. 241, σίμβλον δέ; v. 244, Ἀλλά; v. 263, φιλεῖ δέ; v. 264, δεῖται δέ; v. 268, οὐ μήν; v. 270, Ἀλλά μοι δοκεῖ; v. 277, καὶ τάχ' ἄν; v. 285, ἔστι γάρ.

The chief reasons for the proposed change are briefly:

1. In the two by-plays with the boys, vv. 247-257 and 290-317, the sense points almost certainly to a continuous conversation with *one* of the Choreutae.

2. According to Arnoldt's own principles, a change of speaker is required in some of the verses above indicated and allowed in all.

3. Arnoldt's order of succession is objectionable: (*a*) Because the Choreutes who, v. 252, cuffs the link-boy, occupies an inside position (No. 7 in figure). As proposed, this whole part comes round to the Coryphaeus (No. 9) to whom a link-boy would naturally be assigned. Other scenic advantages will become evident upon examination. (*b*) The Choreutae would more naturally be made to enter into dialogue with the men at their side than with those behind them.

4. It seems less natural that the succession of parts should run along the *files*, i. e. first the file next the θέατρον and so on, than that the *ranks*, as they successively near the focus of interest, should carry on the action.

5. The arrangement proposed brings the centre of interest back again to the Coryphaeus.

6. The fourfold division of the Chorus, vv. 334-434, in the Epeisodion, strengthens the threefold division in the part under discussion: for the Chorus has now faced around towards Bdelycleon's house, and the succession by file becomes of necessity the transverse order.

The external shape of the Chorus is of course κατὰ στοίχους throughout.

(5) MR. J. W. BRIGHT reviewed Earle's Anglo-Saxon Primer.

Historical and Political Science Association.

February 20, 1880.

(1) DR. H. B. ADAMS read the principal paper, Land Community the Historic Basis of State Life.

It was shown that the State, historically considered, does not rest upon Social Contract, but upon a communal basis consisting originally of tribes or families united by blood relationship and holding landed property in common. From the fundamental fact of the sovereignty of the community over its landed possessions, arose the legal idea of Eminent Domain, by which the State can appropriate any land within its limits. That Land Community, in one shape or another, is the foundation-principle of State Life, and that through the State all landed titles come, was shown from the following historic examples:

(1) The Commonwealths of Greece and Grecian Colonies, which were founded upon the principle of landed community. The Greek word for people, and *Deme*, according to Curtius' *Studien* (vi, 401-16), comes from the root *da*, signifying to divide, and refers primarily to the Common Land that was divided up by lot;

(2) The Tribal settlements of ancient Rome, which were more or less communal, as was also the division of the *Ager Publicus*. The Patricians were simply an association of old settlers who were opposed to new comers, the Plebeians. The agrarian controversies, which fill Roman history, have their exact counterpart in the history of many New England Towns, where the Commoners opposed the claims of new comers to a share in the Common Lands:

(3) The Village Communities of ancient Germany, which were of the communal type and furnished the germs of Self-Government for Saxon England;

(4) The Anglo-Saxon Towns and Local Kingdoms, which grew up from Germanic and communal beginnings;

(5) The Towns of New England and the Local Self-Government of America, which are simply the outgrowth of old Saxon ideas, preserved in England throughout the Middle Ages under the very heel of Feudalism;

(6) The American Union, based primarily, not upon Articles of Confederation, but upon the common desire of the American Colonies for united territorial independence of Great Britain and for Local Self-Government in States, and, secondarily, upon the common relation of the individual States to the Western Lands, acquired by the Revolution and ceded to the Old Confederation at the instance of Maryland (see Fund Publication, No. II, Md. Hist. Soc.), thus founding a really National Commonwealth and a permanent Territorial Union before the Constitution of 1787 was adopted.

(2) **LEE SALE** presented a minor communication on The Origin of Italian Municipalities.

It was shown that the Italian boroughs were not the perpetuation of Roman municipalties, but were purely of Germanic origin. The Roman *Curia* of the fifth century was a worn-out institution, an instrument of slavery rather than of government, and could not have furnished the life-giving principle of the energetic mediæval borough. The names *Consul*, *Curia*, &c., which seem to connect the Italian cities with Rome, are really the expression of institutions quite new. The boroughs owe their power and liberty to the union of the nobility with the superior class of tradesmen.

(3) **EDGAR GOODMAN** reviewed Laveleye's work on Primitive Property, with special reference to the history of the Swiss *Almends* or communal associations.

Uri, Glaris and Valais were taken as types to explain how the Commoners enjoy their privileges in the various Cantons, and many striking parallels were indicated in the local government and usages of Switzerland and New England. The social and economic position of the Swiss mechanic was compared with that of the English workman, much to the advantage of the former.

Mathematical Seminary.

February 18, 1880.

(1) **MR. MITCHELL**: On a Completion of Fermat's Theorem.

When no restriction is put upon x in the congruence $x^{\tau(M)} \equiv R$ (*mod.* M), R was shown to have 2^n different values, n being the number of unequal prime factors in M, and $\tau(M)$ being the number of numbers less than and prime to M.

First: If two numbers contain the same set of unequal prime factors in common with a modulus M, they give the same value of R. Since there are 2^n classes of numbers when classified in this way, R can not have more than 2^n different values.

Secondly: Since $x^k \equiv x$ (mod. M) has 2^n unequal roots, R has exactly 2^n values.

These values of R occur in pairs, mutually conjugate with respect to $M+1$.

Calling the g. c. d. of R and M, δ, $R \equiv 1$ (*mod.* $\frac{M}{\delta}$).

The two theorems, $x^{\tau(M)} \equiv R$ (*mod.* M), and $R \equiv 1$ (*mod.* $\frac{M}{\delta}$) become the Fermatian theorem in the special case of $\delta = 1$, for then $R = 1$.

$x^{\tau(M)} - R_k \equiv O$ has $\Sigma\, \tau\left(\frac{M}{\theta}\right)$ roots, where $\theta = \delta$, or any divisor of δ that contains all its unequal prime factors.

(2) **MR. HATHAWAY**: On Generalized Forms of Trigonometrical Ratios.

The ratios of the sides of a triangle (paying attention to their directions as well as to their lengths) are determinate functions of the angles. These functions are periodic in each variable, with period 2π, *i. e.*, $f(\omega, \alpha) = f(\omega + 2r\pi, - \alpha + 2s\pi)$. If π be added to ω, or to α, or to both, which reverses the directions of corresponding lines, then in each case a corresponding four of the $3 \times 2 \times 1 = 6$ ratios of the sides change sign or are semi-periodic for the period π, and the other two remain unchanged, or are periodic. If α be changed to $-\alpha$, ω to $-\omega$, which is equivalent to a semi-revolution of the triangle about the side common to ω and α as axis, no change is made in any of the ratios, *i. e.* $f(\omega, \alpha) = f(-\omega, -\alpha)$, or $f(\omega, \alpha)$ is an even function. Selecting, in the triangle AOB, $\angle AOB = \alpha$, $\angle^{AB}_{OA} = \omega$, we may name the different functions as follows:

$$\frac{OA}{OB} = \cos(\omega, \alpha) \left[\text{or } \cos \omega\alpha\right], \frac{AB}{OB} = \sin(\omega, \alpha), \frac{\sin}{\cos} = \tan, \quad \frac{1}{\sin} = \csc,$$
$$\frac{1}{\cos} = \sec, \quad \frac{1}{\tan} = \cot.$$

The lines OA, OB, divide the plane into four compartments similar to quadrants. *E. g.*, $\cos(\omega, o) = 1$, $\cos(\omega, \omega) = 0$, $\cos(\omega, \pi) = -1$, $\cos(\omega, \pi + \omega) = 0$, $\cos(\omega, \omega - \alpha) = \sin(\omega, \alpha)$, &c. With these lines as axes, the cosine and sine are the x and y coördinates of the extremity of $\rho = 1$; thus $\sin^2 + 2 \cos\left(\frac{\pi}{2}, \omega\right) \cos \sin + \cos^2 = 1$.

Other formulae are: $\sin(\omega, -\alpha) = -\sin(\omega, \alpha)$, $\sin^2(\omega, \alpha) + \cos(\omega,$ $\cos(\omega, -\alpha) = 1$, $\sin(\omega, \alpha) = \csc(\alpha, \omega)$, $\cos(\omega, \alpha) = -\cot(\alpha, \omega)$, $\sin(\omega, \alpha)$
$\frac{\sin(\theta, \alpha)}{\sin(\theta, \omega)} = \frac{\sin\alpha}{\sin\omega}$, $\cos(\omega, \alpha) = \frac{\sin(\theta, \omega - \alpha)}{\sin(\theta, \omega)} = \frac{\sin(\omega - \alpha)}{\sin\omega}$.

$$\cos(\omega, \alpha + \beta) = \cos(\omega, \alpha)\cos(\omega, \beta) - \sin(\omega, \alpha)\sin(\omega, \beta),$$
$$\sin(\omega\ \alpha - \beta) = \sin(\omega, \alpha)\cos(\omega, \beta) - \cos(\omega, \alpha)\sin(\omega, \beta),$$
$$\cot(\alpha + \beta, \omega) = \csc(\alpha, \omega)\csc(\beta, \omega) - \mathrm{ct}\ (\alpha, \omega)\,\mathrm{ct}\,(\beta, \omega),$$
$$\csc(\alpha - \beta, \omega) = \mathrm{ct}\ (\alpha, \omega)\csc(\beta, \omega) - \csc(\alpha, \omega)\,\mathrm{ct}\,(\beta, \omega).$$

The analytical formulae of oblique axes are rendered very similar to th of rectangular axes by the use of these generalized functions.

DR. STORY remarked that Unverzagt in his work on "*Goniometris Quaternionen*" has developed this theory.

(3). **DR. STORY**: On Volumes and Surfaces of n-Dimensio Spheres.

An n-dimensional sphere is that portion of an n-dimensional space wh is the locus of all points lying between a fixed point, the centre of the sph and the points (whose locus is n-1-dimensional) which are at a constant tance r from the centre. The (n-1)-dimensional locus is the surface of sphere and r is its radius. The measure of any portion of n-dimensio space is the ratio of the number of points contained in it to the numbe points in the n-dimensional cube whose edge is the unit of length, on hypothesis that the points are equally distributed throughout the portions space in question. A no-dimensional space cannot be divided; the meas of a portion of space made up of no-dimensional spaces is the number of s spaces of which it consists.

Let $V_r^{(n)}$ and $S_r^{(n)}$ be respectively the volume and surface of an n-dim sional sphere (or, better, *circular figure*) of radius r. Let $\rho = \sqrt{r^2 - x^2}$,

$\frac{x}{r} = \sin\vartheta$; then $\rho = r\cos\vartheta$ and $V_r^{(n)} = 2r\int_0 V_\rho^{(n-1)}.dx = 2\,r\int_0^{\frac{1}{2}\pi} V_\rho^{(n-1)}\cos\vartheta.$

Thus, assuming $V_r^{(2)} = \pi . r^2$, by means of the formulae

$$\int^{r}\rho^{2n}.dx = r^{2n+1}\int_0^{\frac{1}{2}\pi}\cos^{2n+1}\vartheta.d\vartheta = \frac{2.4.6\ldots(2n)}{3.5.7\ldots(2n+1)}.r^{2n+}$$
$$\int_0^{r}\rho^{2n+1}.dx = r^{2n+2}\int_0^{\frac{1}{2}\pi}\cos^{2n+2}\vartheta.d\vartheta = \frac{1.3.5\ldots(2n+1)}{2.4.6\ldots(2n+2)}.\frac{\pi}{2}r^{2n+}$$

we find $V_r^{(3)} = \frac{4}{3}\pi . r^3$, $V_r^{(4)} = \frac{1}{2}.\pi^2.r^{(4)}$, $V_r^{(5)} = \frac{2^3}{3.5}.\pi^2.r^5, \ldots.$

Practically a simpler method is to assume $V_r^{(n)} = C^{(n)} . r^n$, where C is a numerical coefficient depending only on n.

Then we have

$$C^{(n)} = 2C^{(n-1)}\int_0^{\frac{1}{2}\pi}\cos^n\vartheta\, d\vartheta;$$

thus

$$C^{(2n)} = 2C^{(2n-1)}\frac{1.3.5\ldots(2n-1)}{2.4.6\ldots(2n)}.\frac{\pi}{2}, \quad C^{(2n+1)} = 2C^{(2n)}\frac{2.4.6\ldots(2n)}{3.5.7\ldots(2n+}$$

i. e.
$$C^{(2n)} = \frac{\pi}{n}.C^{(2n-2)}, \quad C^{(2n+1)} = \frac{2\pi}{2n+1}.C^{(2n-1)};$$

but $C^2 = \pi$, $C^3 = \frac{4}{3}\pi$, hence

$$C^{(2n)} = \frac{1}{1.2.3\ldots n}.\pi^n, \quad C^{(2n+1)} = \frac{2^{n+1}}{1.3.5\ldots(2n+1)}.\pi^n.$$

These formulae give by analogy, $C^{(0)} = 1$, $C^{(1)} = 2$.*

It is easy to prove that the volume of an n-dimensional triangular pyram better, *triangular figure*) is one nth of the volume of the triangular pri having the same base and altitude, *i. e.* is measured by one nth of the prod of its base by its altitude. Now any n-dimensional sphere may be divid into an infinity of n-dimensional triangular pyramids having a common ver at the centre of the sphere, their bases in its surface, and for their comm altitude the radius of the sphere. Hence, the volume of the sphere is one of its surface multiplied by its radius, *i. e.* $V_r^{(n)} = \frac{r}{n}S_r^{(n)}$, or $S_r^{(n)} = \frac{n}{r}V_r$

Thus

$$S_r^{(2n)} = \frac{2}{1.2.3\ldots(n-1)}.\pi^n.r^{2n-1}, \quad S_r^{(2n+1)} = \frac{2^{n+1}}{1.3.5\ldots(2n-1)}.\pi^n,$$

For 6 or less dimensions we have then

$$\begin{array}{llllllll} n & = 0, & 1 & , 2 & , 3 & , 4 & , 5 & , 6 \\ V_r^{(n)} & = 1, & 2.r & , \pi.r^2 & , \frac{4}{3}\pi.r^3 & , \frac{1}{2}\pi^2.r^4 & , \frac{8}{15}\pi^2.r^5 & , \frac{1}{6}\pi^3.r^6 \\ S_r^{(n)} & = 0, & 2 & , 2\pi.r & , 4\pi.r^2 & , 2\pi^2.r^3 & , \frac{8}{3}\pi^2.r^4 & , \pi^3.r^5. \end{array}$$

The formulae

$$\frac{S_r^{(2n)}}{V_r^{(2n-1)}} = \frac{3.5.7\ldots(2n-1)}{2.4.6\ldots(2n-2)}\pi, \quad \frac{S_r^{(2n+1)}}{V_r^{(2n)}} = 2.\frac{2.4.6\ldots(2n)}{1.3.5\ldots(2n-1)},$$

of which $\frac{S_r^{(2)}}{V_r^{(1)}} = \pi$, $\frac{S_r^{(1)}}{V_r^{(0)}} = 2$, are special cases, are interesting as being the g eralization of the fact that the area of the surface of a three-dimensio sphere is four times the area of one of its great circles.

* It should be noticed that the one-dimensional circular figure is a straight l whose length is $V_r^{(1)} = 2r$, and whose surface is the pair of points measured by $S_r^{(1)} =$

March 17, 1880.

(1) **PROFESSOR SYLVESTER**, On the Triangles in- and ex-scribable to a General Cubic Curve.

The general cubic being thrown into the form $xy^2 + yz^2 + zx^2 + mxyz = o$, the lines $x = o$, $y = o$, $z = o$ will constitute an in- and ex-scribable triangle to the curve. The number of such was stated to be 24; consisting of 12 pairs of conjugates, each pair being in triple-perspective position with respect to each other, and the centres of the perspective projection being three collinear points of inflexion. Accordingly, the twenty-four triangles will consist of 4 groups of three pairs of conjugate in- and ex-scripts. The law for the number of polygonal in- and ex-scripts, with any assigned number of sides will be found stated in No. 4, Vol. II, of the *American Journal of Mathematics*.

(2) **MR. MITCHELL**: On Binomial Congruences (Second paper).

For the prime modulus, a, $x^n \equiv R$ (mod. a) has $\alpha + 1$ roots, where α is the g. c. d. of n and $\tau(a)$. R means a totient-residue and has here two values, 0 and 1. $X^n \equiv$ (mod. ab) has $(\alpha+1)(\beta+1)$ roots, and so on for moduli, abc, &c.

$X^n \equiv R$ (mod. a^i) has $\alpha + a^{i-P\left(\frac{i}{n}\right)}$ roots. $P\left(\frac{i}{n}\right)$ denotes the number of integers in $\frac{i}{n}$, plus one, if there be a fraction. R has two values, 0 and 1; for $R = 1$ the congruence has α roots; for $R = 0$, $a^{i-P\left(\frac{i}{n}\right)}$ roots.

Then $x^n \equiv R$ (mod. $a^i b^j c^k$) has $\left(\alpha + a^{i-P\left(\frac{i}{n}\right)}\right)\left(\beta + b^{j-P\left(\frac{j}{n}\right)}\right)\left(\gamma + c^{k-P\left(\frac{k}{n}\right)}\right)$ roots, and the different terms of the expansion give the number of roots for the 2^m separate values of R, m being the number of different prime factors in the modulus.

If one of the prime factors of the modulus, as a, $= 2$, i being greater than 2, the α of the formula must be multiplied by 2 when it is greater than unity.

The first part of the theorem in respect to prime moduli given, for instance, in Serret's *Cours D'Algèbre Supérieure*, Art. 310, can be generalized as follows:

Denoting by $\kappa(M)$ the period of the modulus M, if $x^{\theta} \equiv \xi$, (mod. M), then $\zeta^{\frac{\kappa(M)}{\theta}} \equiv R$ (mod. M), θ being any divisor of $\kappa(M)$. The reciprocal is not true in general. $x^{\kappa(M)} - R \equiv 0$ can be written $(x^{\frac{\kappa(M)}{2}} - R)(x^{\frac{\kappa(M)}{2}} + R) \equiv 0$, since $R \equiv R^2$ (mod. M). The quadratic residues of M are all roots of $x^{\frac{\kappa(M)}{2}} - R \equiv 0$, therefore all the roots of $x^{\frac{\kappa(M)}{2}} + R \equiv 0$, are *non-quadratic* residues. Some of the *non-residues* may be roots of $x^{\frac{\kappa(M)}{2}} - R \equiv 0$, and some may be roots of neither of the two latter congruences, but of their product.

Other theorems for prime moduli can be generalized for any modulus.

[For proofs, &c., See Journal of Math. Vol. III, No. 1].

(3) **MR. STRINGHAM**: On Rotation in Four-dimensional Space.

The rotation of a particle, or point, about a plane in four-dimensional space may be defined as such a motion of the particle that a radius vector drawn from a fixed point in the plane to the particle shall always remain constant in length and perpendicular to the plane.

If this radius vector be drawn perpendicular to the three-dimensional flat space in which the given plane is situated, since it is perpendicular to every line in that space, the plane may be rotated in that space, about the foot of the radius vector and still remain perpendicular to it; or, since the perpendicularity of the line to the plane depends on their *relative* positions alone, the *line* may also be rotated about the fixed point in the plane (the plane being fixed) in some *other* particular space of 3 dimensions than the one before considered and still remain perpendicular to the plane; that is to say

THEOREM I: *A rotation about a plane in four-dimensional space is equivalent to a rotation about a point in three-dimensional space.*

From this theorem it follows as a direct consequence that "if a fourth-dimension were added to space, a closed material surface could be turned inside out without either stretching, or tearing." [See Professor Newcomb's Note in Amer. Jour. of Math., Vol. I., No. 1, p. 1.] For a material point on one side of the surface will reverse its aspect on being rotated to the *opposite* side.

THEOREM II: *The four-dimensional surface generated by the revolution of a plane polygon about a fixed plane in four-dimensional space is equivalent to the two dimensional area of the projection of the polygon on the rotation plane, multiplied by the circumference of the circle whose radius is the length of the normal to the given polygon at its centre of gravity intercepted by the rotation plane.*

Let A = area of the given polygon, A′ = its projection on the rotation plane, a = the normal above described, p = the perpendicular let fall from the centre of gravity of the given polygon to the plane; then $\frac{a}{p} = \frac{A}{A'}$.

Thus if Z = area of four-fold zone generated by a complete revolution,

$$\therefore Z = 2\pi p . A = 2\pi a A'. \qquad \text{Q. E. D.}$$

Theorems similar to these may be proven for the higher-fold spaces.

If the 3-fold hemisphere of radius r be considered as made up of an infinite number of plane polygons, its projection on a diametral plane has for its area the area of a great circle, and theorem II. gives

$$S_{(4)} = 2\pi r . \pi r^2 = 2\pi^2 r^3,$$

as the area of the 4-fold sphere. [See Dr. Story's paper on n-dimensional spheres, in this *Circular*.] Comparing this with the formula

$$V_{(4)} = 2\pi^2 r^3 . \frac{r}{4} = \tfrac{1}{2}\pi^2 r_4,$$

and carrying the process to the higher-fold spaces, it is easy to see that in general $S_{(n)} = 2\pi r V_{(n-2)}$.

The following formulae are thence easily deduced:

$$S_{(n)} = \frac{2\pi r^2}{(n-2)} S_{(n-2)}, \quad V_{(n)} = \frac{2\pi r^2}{n} V_{(n-2)}; \quad S_{(2n)} = \frac{2\pi^n r^{2n-1}}{(n-1)!},$$

$$S_{2n+1} = \frac{2\pi^n r^{2n}}{(n-\frac{1}{2})!}; \quad V_{(2n)} = \frac{\pi^n r^{2n}}{n!}, \quad V_{(2n+1)} = \frac{\pi^n r^{2n+1}}{(n+\frac{1}{2})!};$$

where $S_{(k)}$ means the surface and $V_{(k)}$ the volume of the k-fold sphere.

Metaphysical Club.

March 9, 1880.

(1) **MR. PEIRCE**: On Kant's "Critic of the Pure Reason" in the light of Modern Logic.

Mr. Peirce compared Kant's solution of the problem "How are synthetical judgments *à priori* possible?" with the solution given by modern logic of the problem "How are synthetical judgments in general possible?" He showed that the reply which Kant makes to the former question has its analogue with reference to the latter. This analogous answer to the second question is true, indeed, but is far from being a complete solution of the problem. On the other hand, the solution which modern logic gives of its question may be successfully applied to Kant's problem; but this does not enable us to discover the origin of the conceptions of space and time. The categories of Kant were next considered. The list given by him is built upon the basis of a formal logic which subsequent criticism has undermined and carried away. Nevertheless there really do exist relationships between some of those conceptions and logic on the one hand and time on the other. The explanation of these relationships in conformity with modern logic, though far more definite than that of Kant, is not altogether dissimilar to it.

(2) **MR. STRINGHAM** gave a *resumé* of Dr. Ernst Schröder's *Operationskreis des Logikkalkuls.*

The main features of Schröder's system are, (1) its dualistic arrangement, by which to every addition equation a multiplication equation is made to correspond (and *vice versa*), (2) the transformation of every logical equation into a form in which the right hand member is zero, and (3) more especially his announcement of a *Haupttheorem* by means of which by a single operation two equations are obtained, from one of which any given class symbol is eliminated, while the other gives its value. The method of (2) is identical with that of Jevons.

The fundamental departure from Boole's system is in the definition of logical addition, wherein Schröder corrects the error of Boole, who assumed that logical addition presupposes the mutual exclusion of the class symbols added. This correction Schröder adopts from Robert Grassmann.

The following equations are important in Schröder's method and display its dual character. No. 20 with its five adjuncts is the *Haupttheorem.*

5° $aa = a$; | 5′ $a + a = a$.
6° $a(b + c) = ab + ac$; | 6′ $a + bc = (a + b)(a + c)$.
7° $aa_1 = o$; | 7′ $a + a_1 = 1$;

where a_1 means not-a. Every class symbol may be put into either of the two forms

14° $b = xa + ya_1$; | 14′ $b = (y + a)(x + a_1)$;

where x and y are arbitrary.

16° If $a + b = o$, $\therefore a = b = o$; | 16′ If $ab = 1$, $\therefore a = b = 1$.

The equation $a = b$ may always be transformed into either of the forms, 17°, 17′:

17° $ab_1 + a_1 b = o$; | 17′ $ab + a_1 b_1 = 1$.

The negations of ab and of (a + b) are

18° $(ab)_1 = a_1 + b_1$; | 18′ $(a + b)_1 = a_1 b_1$.

By means of 17° every logical equation involving the class symbol a may be put into the form

20 $xa + ya_1 = o$:

and from this equation are deduced any and all of the five relations,

$$xy = o; \quad a = ux_1 + y;$$
$$a = (u + y)x_1, \; a = (uy_1 + y)x \quad a = ux_1 y_1 + y;$$

where u is an arbitrary class symbol.

An illustration of the application of this method was given by the solution of the question given by Boole—*Laws of Thought*, p. 146.

The preface to Dr. Schröder's book is dated March, 1877. Following this, the author gives a short bibliography of the subject in which he mentions the names of Trendelenburg, Boole, Cayley, Ellis and the two Grassmanns, Robert and Hermann. From this it is to be inferred that he was unacquainted with the investigations of the two writers who, some ten years before his own book was published, had made the most important additions to Boole's system, viz.: Peirce and Jevons. Hence, Schröder's work is chiefly a reproduction of what had already been done by these two writers. His *Haupttheorem*, however, is unique.

MR. PEIRCE remarked that Professor Jevons and himself, independently of each other, had corrected Boole's error concerning the mutual exclusion of classes in logical addition, the former in a pamphlet entitled "Pure Logic or the Logic of Quality," 1864, the latter in a paper on "An Improvement in Boole's Calculus of Logic," read before the *American Academy*, May, 1867; and that in the latter paper the dual character of the subject was plainly exhibited. a fact acknowledged by Schröder in a note in a recent number of *Königsberger's Reportorium*. Mr. Peirce then gave an illustration of his own method as applied to the solution of the question that had just been solved by Schröder's method.

HISTORY OF BRITISH PHILOSOPHY.

Professor George S. Morris, Lecturer on Philosophy, is giving a course of expository and critical lectures on the History of British Philosophy, designed for special and advanced students, on Tuesdays and Saturdays, at 9 A. M., and Thursdays, at 11 A. M.

Undergraduate students previously instructed in Logic and Psychology, who shall follow this course and pass a satisfactory examination on the general subject-matter of the same, and also upon some one or more of the masterpieces belonging to the history of British Philosophy, (for example, Bacon's Novum Organum, Locke's Essay, Berkeley's Principles and Siris, Hume's Treatise, Reid's Intellectual Powers, Hartley on Man, James Mill's Analysis, Sir William Hamilton's Metaphysics, the Logic of John Stuart Mill, or the like), may be credited with the completion of a Minor Course.

The object of these lectures is (after referring students for a general sketch of earlier British speculation to Public Lectures 2 and 3 — see page 32, University Circulars, No. 3) to begin with Francis Bacon, and trace the historical development of speculative thought in Britain down to the present day. This will include:

(1) Bibliographical details: designation of leading works of the authors discussed; various editions; historical works, general and special, relating to the whole subject-matter or to particular parts; and the like.

(2) Exposition of the views of successive thinkers, both in themselves, and in their relation to the general development of British thought.

(3) Critical estimate of the value or justness of these views. This will involve a gradual determination of the nature of philosophy and of philosophical questions, without a distinct conception of which no "critical estimate" is possible. In this way the course must become a course of instruction, at once elementary and advanced, in philosophy generally.

The following lists contain the names of the authors whom it is proposed to discuss. Some of the less important names are printed in smaller type.

1. *Speculative and Psychological Writers:*

Francis Bacon (1561–1626).
Thomas Hobbes (1588–1679).
Ralph Cudworth (1617–1658).
Henry More (1614–1687).
John Smith (1618–1652).
Joseph Glanvill (1636–1680).
John Norris (1657–1711).
John Locke (1632–1704).
Richard Burthogge (–1694).
John Sergeant (1621–1707).
Peter Browne (–1735).
Z. Mayne (–1750).
Robert Boyle (1627–1691).
Isaac Newton (1642–1727).
Samuel Clarke (1675–1729).
Arthur Collier (1680–1732).
George Berkeley (1685–1753).
David Hume (1711–1766).

David Hartley (1705–1757).
Jos. Priestley (1733–1804).
S. T. Coleridge (1772–1834).
James Mill (1773–1836).
John Stuart Mill (1806–1873).
George Henry Lewes (1817–1878).
Alexander Bain (1818–).
Herbert Spencer (1820–).
H. L. Mansel (1820–1871).
S. H. Hodgson.

Scotch School:

Thomas Reid (1710–1796).
Dugald Stewart (1753–1828).
Thomas Brown (1778–1820).
Sir William Hamilton (1788–1856).
James Ferrier (1808–1864).

2. *Ethical Writers:*

Richard Cumberland (1632-1718).
B. de Mandeville (1670–1733).
Samuel Clarke (1675–1729).
William Wollaston (1659–1724).
Earl of Shaftesbury (1671–1713)
Francis Hutcheson (1694–1747).
Joseph Butler (1692–1752).

John Brown (1715-1776).
Adam Smith (1723-1790).
Jeremy Bentham (1747–1782).
John Stuart Mill (1806–1873).
Herbert Spencer (1820–).
Henry Sidgwick.

CHESAPEAKE ZOÖLOGICAL LABORATORY.

Extension of its Operations.

The Trustees of the University, at a meeting held March 1, decided to extend the work of the Chesapeake Zoölogical Laboratory, which has been maintained during the past two years under the direction of Dr. W. K. Brooks, Associate in Biology. A fuller statement of the plans adopted will be made in the course of a few weeks.

The work thus favored is in accord with the methods of zoölogical investigation which are now followed by the most advanced universities of Europe.

In this country, the private laboratory of Professor Alexander Agassiz at Newport, R. I., and the station of the United States Fish Commission at Wood's Holl, Mass., afford kindred opportunities each year to a few zoölogists.

Zoölogical stations are maintained abroad as follows:

The Naples Station, which was the first permanent public marine laboratory, was founded about 1872 by Dr. Dohrn, at his own expense, but he was aided in completing and conducting it by subscriptions from many of the governments, universities and learned societies of Europe. These bodies can send persons to occupy tables at the laboratory. Tables are also rented to other persons at one thousand dollars a year, including service of collectors, aid of scientific staff, etc.

In 1878 more than one hundred naturalists, among them many leading zoölogists of Europe, had used the station, and various Journals in several languages have contained papers based on investigations made here. Among these are several of the most important monographs of the past eight years. The Station also publishes a quarterly illustrated volume of "Arbeiten," and occasional larger papers. The staff will hereafter issue a Zoölogical Record of abstracts of all zoölogical publications, a work for which they now have unrivaled facilities.

A marine laboratory has been established at Kiel, by the "Association of German Naturalists and Physicians," with government aid, and has done some excellent work.

The "Association of Russian Naturalists" have two stations, one on the Crimea, and the other also in the south of Russia.

The "Netherlands Zoölogical Society" has a permanent marine station, with outfit, and a smaller transportable laboratory, and receives aid from the State. It has furnished some valuable results.

The University of Vienna has a permanent laboratory, with staff and outfit, at Trieste. It has published one large illustrated quarto volume of results, and others are in preparation. Dr. Claus is Director.

The Sorbonne has a station at Roscoff under the direction of Professor Lacaze Durthiers.

The University of Lille has permanent buildings and outfit at Wimeraux, under Professor Giard.

The University of Aberdeen has just organized a small marine station on the Scottish coast.

The University of New South Wales has erected a marine station, partly by subscription.

NATURALISTS' FIELD CLUB.

There will be a meeting in the Biological lecture room, at 4 P. M., on Thursday, April 8th, to take into consideration the advisability of organizing a Field Club for the study of the Fauna, Flora and Geology of the neighborhood of Baltimore. It is proposed to make Saturday excursions during the finer months of the year, and accumulate collections illustrative of the above subjects. All members of the University are invited to attend and cooperate.

Hopkins Hall Lectures, at 5 P. M.

Political Economy, by HENRY C. ADAMS, (Ph. D., and late Fellow of the Johns Hopkins University). Nine lectures on ***National Debts.***

Dates and Special Topics.

1. *Friday, April* 2. The growth of great National Debts, and their social and political tendencies.
2. *Friday, April* 9. Economic effects of National Debts.
3. *Friday, April* 16. Necessity of public Debts and the conditions under which they may justly be contracted.
4. *Friday, April* 23. Various forms of public Debts and the methods of contracting them.
5. *Friday, April* 30. Management and employment of Debts while outstanding, and the methods by which they may be liquidated.
6. *Friday, May* 7. The French Debt and the payment of the five milliards.
7. *Friday, May* 14. The English Debt.
8. *Friday, May* 21. The American Debt from 1787 to 1836.
9. *Friday, May* 28. The American Debt from 1836 to 1880.

Note from the Biological Laboratory.

In studying the segmentation of the eggs of *Amblystoma punctatum*, our large, yellow-spotted salamander, it is readily seen that the process is not a continuous one, showing unceasing activity. There are well marked periods of rest and activity which regularly alternate. It is a true rhythmic action.

These resting stages in segmenting eggs, have been observed in various invertebrates, but so far as I know, this is the first record made of the same thing in the vertebrates. Among the invertebrates it seems to have been most often noticed in the eggs of mollusca, both in Gasteropods and Lamellibranchs. Lovén records it in the eggs of the European oyster, at least thirty years ago, but without attaching any special importance to it. Brobetzky also mentions the same thing in Cardium. It is nowhere shown more prominently than in the segmenting eggs of the American oyster, as shown by Dr. Brooks. It has also been noticed in other groups of invertebrates, and it seems to me quite probable that it will prove to be a universal characteristic throughout the animal kingdom.

The best explanation of the significance of this mode of growth, is that given by Dr. Brooks. His idea is that during an active period the supply of energy is used up, and during the ensuing stage of rest, a new supply of nutritive, energy-giving material is absorbed.

After the first furrow has made its appearance on the dark hemisphere of an egg of *Amblystoma*, a resting stage of about one hour's duration ensues; this is followed by the formation of the second furrow at right angles to the first, and which reaches entirely across the dark hemisphere within fifteen minutes. Then a second resting stage comes on, lasting from forty-five minutes to an hour and a quarter. This is followed by a period of activity, then a resting stage and so on.

March 27, 1880. S. F. CLARKE.

Additions to Roll of Students.

(Other Lists will be found on pp. 3-5, 14, 35, of University Circulars.)

BRUNE, T. BARTON M. D., University of Maryland, 1877.	207 Maryland Ave.	*Biology.*
BURT, BENJAMIN C. A. B., University of Michigan, 1875, and A. M., 1879.	11 Cathedral St.	*Philosophy.*
LOCKWOOD, WILLIAM F. M. D., University of Virginia, 1875.	117 W. Madison St.	*Biology.*
PENNINGTON, CLAPHAM	36 W. Eager St.	*Chemistry.*
RIVERS, EDMUND C. A. B., Washington College, Md., 1876; M. D., University of Maryland, 1879.	University Hospital.	*Chemistry and Biology.*
WHEELER, ARTHUR W. A. B., Amherst College, 1879.	132 W. Madison St.	*Physics.*
WHITING, GUY F. M. D., University of Maryland, 1878.	42 Oak Ave.	*Biology.*

Total number of Enrolled Students 1879-80, 161, of whom 81 are Graduates.

Brief Announcements.

By invitation of the Trustees, ALEXANDER GRAHAM BELL, Esq., of Washington, has accepted a position on the staff of the Johns Hopkins University. His courses of lectures will be hereafter announced. Mr. Bell is the son of A. Melville Bell, author of "Visible Speech," a work well known to all English philologians, and is himself distinguished for his phonological inquiries and discoveries. It is announced in Nature (Vol. xxi. No. 14, Feb. 5., 1880,) that the *Volta Prize* has been awarded to Mr. Bell by the Committee appointed by the French Minister of Public Instruction.

PROFESSOR ROWLAND has begun a course of about twenty-five lectures on *Thermodynamics*, on Mondays and Fridays at 10 A. M., and Tuesdays and Thursdays at 11 A. M., in Room 8.

PROFESSOR GEORGE S. MORRIS, Lecturer on Philosophy, has begun his courses in Philosophy and Ethics, as announced on page 50. He will be glad to meet those desiring to consult him, between the hours of 10 and 11 A. M., daily, in the room adjoining Hopkins Hall. Professor Morris's city residence is at the St. James Hotel.

PROFESSOR GILDERSLEEVE will give a course of twelve *Readings in the Greek Tragic Poets*, in illustration of his Hopkins Hall lectures, on Tuesdays and Fridays at 12 M., beginning on Thursday, April 1. These readings are intended for undergraduates as well as graduates.

MR. SIDNEY LANIER, Lecturer on English Literature, has formed a class (composed of those who are especially devoted to scientific pursuits) for the study of the *Art of Expression*. This class will meet for the study of Chaucer and Shakspere, in Room 4, on Tuesdays and Saturdays, at 4 P. M.

DR. AUSTIN SCOTT, Associate in History, will be prevented from giving the course of Hopkins Hall lectures, but his class in American History will be formed as announced.

J. R. MCD. IRBY (S. B., University of Virginia, and Ph. D., Göttingen) has resigned his Fellowship in this University, and has sailed for South America, to engage in professional pursuits there.

At the meeting of the Royal Society, London, November 27, 1879, a paper by J. N. Langley, Fellow of Trinity College, Cambridge, and HENRY SEWALL, Ph. D., and late Fellow of this University, *On the Changes in Pepsinforming Glands during Secretion*, was communicated by Professor Michael Foster. [See Nature, London, Dec. 18, 1879, p. 169]. This paper has been published in the Journal of Physiology, London, Vol. III., No. IV.

The American Oriental Society has just completed the tenth volume of its Journal. Pages 325 to 601 comprise an article by DR. C. R. LANMAN, Associate in Sanskrit, *On Noun-Inflection in the Veda.* This has also been published in book form.

This monograph aims at an exhaustive and systematic discussion of the noun-forms in the Rig- and Atharva-vedas. It is primarily a grammatical investigation, and upon it Professor Whitney has based his treatment of the subject in his Sanskrit Grammar, just issued at Leipsic. Secondarily, however, it treats of a great many questions of exegesis, metre, and the text criticism of individual passages. Scattered throughout the work, also, are numerous statistical researches which shed interesting light upon broader problems of Vedic criticism. It is provided with an index of citations, an index of Sanskrit words, and a general index.

The Report of the Commissioner of Fisheries of Maryland for 1880 contains an article by Dr. W. K. BROOKS, Associate in Biology, on the *Development of the American Oyster.* The paper describes the process of obtaining young oysters by artificial fertilization of the eggs, an account of the development of the oyster embryo, and a discussion of a number of theoretical points in general embryology. The article will also appear in the next number of the Studies from the Biological Laboratory of this University.

Candidates proposing to apply, at the end of this academic year, for the degree of Ph. D., are requested to communicate at once with the President.

The forthcoming number of the American Journal of Science will contain a Report of the Result of a Scientific Examination of Mr. Edison's Method of producing the Electric Light, by PROFESSOR ROWLAND, of this University, and PROFESSOR G. F. BARKER, of the University of Pennsylvania.

FELLOWSHIPS.

Twenty Fellowships, each yielding five hundred dollars per annum, are now open to competition in this University.

Object of the Foundation.

The system of Fellowships was instituted for the purpose of affording to young men of talent from any place, an opportunity to continue their studies in the Johns Hopkins University, while looking forward to positions as professors, teachers, and investigators, or to other literary and scientific vocations. The appointments have not been made as rewards for good work already done, but as aids and incentives to good work in the future; in other words, the Fellowships are not so much honors and prizes bestowed for past achievements, as helps to further progress, and stepping-stones to honorable intellectual careers. They have not been offered to those who are definitely looking forward to the practice of either of the three learned professions, (though such persons have not been formally excluded from the competition,) but have been bestowed almost exclusively on young men desirous of becoming teachers of science and literature, or determined to devote their lives to special branches of learning which lie outside of the ordinary studies of the lawyer, the physician and the minister.

Every candidate is expected to submit his college diploma or other certificate of proficiency from the institution where he has been taught, with recommendations from those who are qualified to speak of his character and knowledge. But this is only introductory. He must also submit, orally or in writing, such evidence of his past success in study, and of his plans for the future, together with such examples of his literary or scientific work, as will enable the Professors to judge of his fitness for the post. The examination is indeed in a certain sense competitive; but not with uniform tests, nor by formal questions and answers submitted to the candidates. First the head of a given department considers, with such counsel as he may command, the applicant's record. The Professors then collectively deliberate on the nominations made by individual members of their body. The list upon which they agree, with the reasons for it, is finally submitted by the President of the University to the Executive Committee, and by them to the Trustees for final registration and appointment. By all these precautions, the highest results which were anticipated have been secured. A company of most promising students has been brought together, and their ability as teachers and scholars has been recognized by the calls they have received to permanent and attractive posts in different parts of the country.

Terms and Regulations.

1. The application must be made in writing.
2. The candidate must give evidence of a liberal education such as the diploma of a college of good repute); of decided proclivity towards a special line of study (such as an example of some scientific or literary work already performed); and of upright character (such as a testimonial from some instructor).
3. The value of each Fellowship will be five hundred dollars. In case of resignation, promotion, or other withdrawal from the Fellowship, payments will be made for the time during which the office may have been actually held.
4. Every holder of a Fellowship will be expected to render some services to the institution as an examiner, to give all his influence for the promotion of scholarship and good order, and in general to co-operate in upholding the efficiency of the University, as circumstances may suggest. He must reside in Baltimore during the academic year.
5. He will be expected to devote his time to the prosecution of special study, (not professional) with the approval of the President, and before the close of the year, to give evidence of progress by the preparation of a thesis, the completion of a research, the delivery of a lecture, or by some other method.
6. He may give instruction, with the approval of the President, by lectures or otherwise, to persons connected with the University,—but he may not engage in teaching elsewhere.
7. He may be re-appointed at the end of the year.
8. The appointments will be made for 1880-81, as follows:

In Mathematics, three; Languages, three; Chemistry, three; Physics, three; Biology, three.

The remaining five Fellowships may be given for excellence in these or in any other departments of study.

9. *Applications for the next year should be made prior to May 15th,* 1880.

Appointments, 1876-79.

Name.	College.	State.	Department
Adams, H. C.	Iowa.	Iowa.	*Political Sci*
Adams, H. B.	Amherst.	Mass.	*His*
Allinson, F. G.	Harvard.	N. J.	*Gr*
Ayres, B.	Stevens Inst. Tech.	La.	*Phy*
Bevier, L.	Rutgers.	N. J.	*Gr*
Bloomfield, M.	Furman (S. C.)	Ill.	*Sanskrit and Gr*
Brooks, W. K.	Williams.	Ohio.	*Biol*
Burney, W.	Davidson.	N. C.	*Chemis*
Clarke, S. F.	Yale.	Ill.	*Biol*
Craig, T.	Lafayette.	Pa.	*Mathema*
Fahlberg, C.	Leipsic.	Russia.	*Chemis*
Franklin, F.	Columbian.	Md.	*Mathema*
Gore, J. W.	Va.	Va.	*Mathema*
Hall, E. H.	Bowdoin.	Me.	*Phy*
Hall, L. B.	Amherst.	Mass.	*Chemis*
Halsted, G. B.	Princeton.	N. Y.	*Mathema*
Harding, E. C.	Va.	Va.	*Gr*
Hart, E.	Lafayette.	Pa.	*Chemis*
Hartwell, E. M.	Amherst.	Mass.	*Biol*
Hemphill, C. R.	S. C.	S. C.	*Gr*
Hering, D. W.	Yale.	Md.	*Engineer*
Iles, M. W.	Columbia.	Iowa.	*Chemis*
Irby, J. R. McD.	Va.	Va.	*Mineral*
Jacques, W. W.	Mass. Inst. Tech.	Mass.	*Phy*
Kuhara, M.	Tokio.	Japan.	*Chemis*
Lanman, C. R.	Yale.	Conn.	*Sans*
Marquand, A.	Princeton.	N. Y.	*Logic and Eth*
Means, D. McG.	Yale.	Mass.	*Political Scie*
Mitchell, O. H.	Marietta.	Ohio.	*Mathema*
Morse, H. N.	Amherst.	Vt.	*Chemis*
Nichols, E. L.	Cornell.	N. Y.	*Phy*
Nicolassen, G. F.	Va.	Md.	*Gr*
Ott, I.	Pa.	Pa.	*Biol*
Page, W. H.	Rand. Macon.	N. C.	*Gr*
Poinier, P. P.	Stevens Inst. Tech.	N. J.	*Phy*
Pratt, W. S.	Williams.	Mass.	*Aesthe*
Prentiss, R. W.	Rutgers.	N. J.	*Mathemat*
Preston, E. D.	Cornell.	Pa.	*Engineer*
Rice, H. J.	Cornell.	N. Y.	*Biol*
Royce, J.	Cal.	Cal.	*Philosop*
Savage, A. D.	Va.	Miss.	*Gr*
Sedgwick. W. T.	Yale.	Conn.	*Biol*
Sewall, H.	Wesleyan.	Md.	*Biol*
Sihler, C.	Concordia.	Ind.	*Biol*
Sihler, E. G.	Concordia.	Ind.	*Gr*
Stringham, W. I.	Harvard.	Kans.	*Mathema*
Van Velzer, C. A.	Cornell.	N. Y.	*Mathema*
Van Vorst, F. B.	Princeton.	N. Y.	*Ethics and Metaphy*
Voorhees, H.	Renss. Pol. Inst.	N. Y.	*Chemist*
Wheeler, J. H.	Harvard.	Mass.	*Philol*
Whitman, C. A.	Bowdoin.	Mass.	*Biol*
Wilson, E. B.	Yale.	Ill.	*Biol*
Young, A. V. E.	Mich.	Mich.	*Chemist*

[Total, 53]

Summary.

Of the 33 appointed since instructions began in the University, 14 commen their career here as Graduate Students.

The departments of study of those appointed were as follows: Mathematics, Physics, 6; Chemistry, 9; Biology, 10; Greek, 8; Comparative Philology, 3; His and Political Science, 3; Philosophy, including Aesthetics, 4; Engineering, 2; M eralogy, 1.

Of 33 who have left, 17 are now Instructors in Colleges and Universities, (8 he and 9 elsewhere); 2 are engaged as Teachers in Classical Schools; 2 are attached the United States Coast Survey, and one to the United States Fish Commission; is attached to the Metropolitan Museum of Art, in New York City; 4 others are gaged in the practice of professions other than teaching, (1 Chemist; 1 Civil En neer; 1 Physician; 1 Lawyer); 4 are still pursuing their studies here or abroad.

The Institutions at which those appointed as Fellows, had graduated or recei the Baccalaureate degree, were:

Amherst College,	4	Mass. Inst. of Technology,	
Bowdoin College,	2	Michigan, University of,	
California, University of,	1	Princeton College,	
Columbia College,	1	Randolph-Macon College,	
Columbian University,	1	Rensselaer Polytechnic Inst.,	
Concordia College,	2	Rutgers College,	
Cornell University,	4	South Carolina, University of,	
Davidson College,	1	Stevens Inst. of Technology,	
Furman University, (S. C.,)	1	Tokio, University of, (Japan,)	
Harvard University,	3	Virginia, University of,	
Haverford College,	1	Wesleyan University,	
Iowa College,	1	Williams College,	
Lafayette College,	2	Yale College,	
Marietta College,	1		

JOHNS HOPKINS UNIVERSITY CIRCULARS.

Published with the approbation of the Board of Trustees.

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CALENDAR.

May 27—June 9	**Semi-Annual Examinations [see page 68].**
June 7—10.	**Examinations for Matriculation [see page 56].**
June 11.	**Present Term Closes.**
June 12—September 20.	**Summer Recess.**
September 21.	**Next Term Begins.**
September 22—25.	**Examinations for Matriculation [see page 56].**
September 28.	**Instructions Resumed: Assembly in Hopkins Hall at 8 P. M.**

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MEETINGS OF SOCIETIES, Etc.

Scientific. First Wednesday of each month, at 8 P. M. Next meeting, June 2. S. F. Clarke, Sec'y.

Historical and Political Science. Third Friday of each month, at 8 P. M. H. B. Adams, Sec'y.

Metaphysical. Second Tuesday of each month, at 8 P. M. Allan Marquand, Sec'y.

Philological. First Friday of each month, at 12 M. C. R. Lanman, Sec'y.

Naturalists' Field Club. Saturday of each week, at 2 P. M.

Biological. Thursday of each week, at 4 P. M.

Mathematical Seminary. Third Wednesday of each month, at 8 P. M.

Greek Seminary. Wednesday of each week, at 12 M.

PROGRAMME FOR 1880-81.

The next number of the University Circulars will contain the Programme of Lectures, etc., for the fifth year of instruction, which begins Tuesday, September 21, 1880.

GENERAL STATEMENTS FOR 1880-81.

Instruction is provided for both Collegiate and University students. An examination of the schedule on the following pages will show t character of the work which has been done during the present year. Programmes of the lectures, etc., proposed for the next year, will printed from time to time. Courses are always in progress in Mathematics, Chemistry, Physics and Biology, and in Sanskrit, Gre Latin, German, French and English, as well as in History, Philosophy, Political Economy, etc. The Laboratories are well equipped, a the Library is a select and valuable collection of books.

Admission of Students.

Arrangements are made for the reception of the following classes of students:

I.

Graduates.

Young men who have already graduated in this or other institutions of acknowledged standing are received on the presentation of their diplomas, after satisfying the chief instructors in the departments of study which they propose to follow that they are qualified to pursue the courses here given. They may be enrolled as candidates for the degree of Doctor of Philosophy or not, at their option. Those whose years and attainments correspond with those of graduates may also be received as special students.

II.

Matriculates.

Students who wish a collegiate training are expected, unless excused for some special reason, to offer themselves for matriculation at the time of their admission. If they can pass satisfactorily in a considerable part of the required studies, but not in all, they may be admitted as candidates for matriculation, but their names will not be printed as enrolled students until the examination is completed. They will not be considered as candidâtes for more than one academic year.

Students who present themselves with higher attainments than are requisite for matriculation may, upon examination, receive credit for the same, be admitted to advanced classes, and so graduate in less time than would otherwise be requisite.

III.

Non-Matriculates.

1. STUDENTS IN SUBJECTS PRELIMINARY TO A MEDICAL COURSE. A course of studies, including Physics, Chemistry and Biology, with German, French, English, Psychology and Ethics, has been arranged for the instruction of young men who intend at a later day to pursue the study of medicine.

Those who are not candidates for the degree of Bachelor of Arts may be admitted to this course on passing a prescribed examination as elsewhere stated. If, after entering the University, they desire to become candidates for this degree, they will be encouraged to pass the usual matriculation examination.

2. Young men of collegiate age, who can satisfy a committee consisting of the President and two of the chief instructors that they e sufficiently advanced in character and attainments to be allowed rivilege, and that there is some good reason why they should not offer themselves for matriculation, may be admitted to cert classes; but this privilege may be forfeited at any time, provided t committee is satisfied that there is sufficient reason for its wi drawal.

3. ATTENDANTS UPON LECTURES.—The University has extend certain privileges to teachers following special courses arranged them, to medical students following demonstrations in physiolog and to other persons admitted to the lectures in Hopkins Hall, b they are not regarded as belonging to the University and are enumerated as enrolled students.

Fees for Tuition, Etc.

The charges are as follows, payable in advance, unless, for speci reasons satisfactory to the Treasurer, he permits the payment to deferred:

For Tuition, $80 per annum.

For Materials, etc., in the Chemical, Physical and Biologic Laboratories, extra, according to the amount and character of the wor from $15 to $50 per annum.

Charges are not made for a less period than half a year.

Attendants upon an annual course of lectures in Chemistr Physics or Biology will pay $20 for each course, but if they ta more than one course, or receive instruction in other subjects, th will be expected to pay the regular charge of $80 for tuition in add tion to the charges for materials.

Board and lodging in private houses near the University, includi care of room, fuel and light, may be obtained at five dollars, a upwards, per week. Some students pay even less.

Calendar.

The next term will begin Tuesday, September 21, 1880.

The first week is devoted to the examination of candidates f admission and matriculation, and to the organization of classes. is expected that all the officers of instruction and government will here during this period.

Instructions will be resumed Tuesday, September 28, 1880, up which day there will be a special gathering of all newly admitt students at 5 P. M., and an assembly of all the officers and student in Hopkins Hall, at 8 P. M.

The term of instruction closes on Friday, June 10, 1881.

There will be a recess from Dec. 23, 1880, to January 4, 1881; a also from April 14 to April 19, 1881.

Tuesday, February 22, 1881, will be observed as Commemorati Day.

INFORMATION FOR GRADUATE STUDENTS.

Graduate Courses.

Advanced and graduate students are received with or without reference to their being candidates for a degree, and they are permitted to attend such lectures and exercises as they may individually select. Twenty fellowships are annually awarded.

Special attention is called to the opportunities here afforded for the study of

MATHEMATICS,
PHYSICS,
CHEMISTRY,
BIOLOGY,
LANGUAGE,
LITERATURE,
PHILOSOPHY,
HISTORY.

An idea of the instructions given may be formed from the synopsis of work during the current academic year, which is elsewhere given, and also from the Fourth Annual Report.

The University professors are not absorbed in the details of college routine, but are free to give personal counsel and instruction to those who seek it; books and instruments adapted to investigation and advanced work have been liberally provided; the system of Fellowships secures the presence of twenty special students, imbued with the University spirit, most of them looking forward to academic careers; seminaries limited to a few advanced students, under the guidance of a director, have been organized in Greek, Mathematics, Physics, and History; societies devoted to Philology, to Mathematical, Physical, and Natural Science, and to History and Political Science, afford opportunities for the presentation of memoirs and original communications, and there are also clubs for the reading and discussion of Metaphysical, Biological, Physical, and Chemical papers; during the year, courses of lectures are given by resident and non-resident professors, on topics to which they have given special attention; the libraries of the Peabody Institute and Maryland Historical Society, founded for the advantage of scholars, are easily accessible; the issuing, under the auspices of the Trustees, of publications devoted to Mathematics, Chemistry, Philology and Biology brings the University into advantageous connexion with other scientific foundations; and the University reading-room, which is constantly open, is liberally supplied with new and with standard books and with the literary and scientific journals of this and other lands.

The instruction is carried on by such methods (varying of course with individual scholars, and with the different departments of work) as will encourage the student to become an independent and original investigator, while he is growing more and more familiar with the work now in progress elsewhere, and with the results which have been obtained by other scholars in the same field, and while he is adding to his general intellectual culture. Within reasonable limits, the University will provide such books, apparatus and material as may be requisite for this purpose.

Specific announcements of the work proposed for graduate students during the next year will be published, and will be sent on application.

Degree of Doctor of Philosophy.

The Degree of Master of Arts and Doctor of Philosophy will be conferred in conformity with the following regulations:

Every candidate for the degree of A. M. and Ph. D. will be required:

1. To have obtained the Baccalaureate degree of this University (or to present the diploma of some other college which the Faculty shall accept as equivalent), and to have subsequently devoted not less than two years to University study in the special department of learning which he may have chosen. The appointment to a Fellowship will be regarded by the Faculty as equivalent to the attainment of a Bachelor's Degree, so far as this is a necessary condition of obtaining a higher degree.

2. To produce a thesis which shall be approved by the Faculty. This thesis must be the result of original investigation in the main subject for examination, and the subject of the thesis must be submitted for approval to the head of the department, or the chief examiner in it, not less than six months before the degree is conferred.

3. To pass an examination in one main and one or more subsidiary subjects; the choice of which is to be referred by the candidate to the chief examiner, and through him to the Faculty for final approval. The method of examination will vary according to the subject, and will be written, oral, practical, or all three, as may be deemed best.

4. To enrol himself as a candidate for the degree, at least one year in advance of the time when he proposes to apply for examination.

Degrees will be conferred by the Trustees on the recommendation of the Faculty, probably twice a year, in the middle of the winter and at the end of the academic term.

The Diploma will indicate the department of study to which the candidate has directed his attention.

DEGREES CONFERRED.—The degree of Doctor of Philosophy has been conferred on the following named persons, who have passed the required examinations:

1878.

HENRY C. ADAMS, A. B., Iowa College, 1874; now Lecturer on Political Economy at Cornell University and at the Johns Hopkins University.

THOMAS CRAIG, C. E., Lafayette College, 1875; now of the U. S. Coast and Geodetic Survey, and Lecturer on Mathematics at the Johns Hopkins University.

JOSIAH ROYCE, A. B., University of California, 1875; now Instructor in English Language and Literature at the University of California.

ERNEST G. SIHLER, Concordia College, 1869; now Teacher of Classical Languages, New York City.

1879.

MAURICE BLOOMFIELD, A. M., Furman University (S. C.), 1877; now Student of Philology at the University of Vienna.

SAMUEL F. CLARKE, Ph. B., Yale College, 1878; now Assistant in Biology at the Johns Hopkins University.

GEORGE B. HALSTED, A. B., Princeton College, 1875; now Tutor of Mathematics in Princeton College.

EDWARD HART, S. B., Lafayette College, 1874; now Adjunct Professor of General Chemistry in Lafayette College.

WILLIAM W. JACQUES, S. B., Massachusetts Institute of Technology, 1876.

HENRY SEWALL, S. B., Wesleyan University, 1876; now Student of Biology at the University of Leipsic.

1880.

FABIAN FRANKLIN, Ph. B., Columbian University, 1869; now Assistant in Mathematics at the Johns Hopkins University.

INFORMATION FOR COLLEGIATE STUDENTS.

Collegiate instruction is provided for undergraduate students, especially for young men from Baltimore and its vicinity.

Some peculiar arrangements in our plans may be regarded as advantageous. The large number of teachers in proportion to the scholars gives to the latter the advantage of close personal observation and guidance. The abandonment of the traditional class system enables those who are favored by the possession of uncommon talent, health, or early advantages, to push forward in their studies as rapidly as they choose: while it allows those whose early training has not been so good, or whose health fails, or who need to spend a part of their time in acquiring a support, to prolong their course over a longer period than is usual. The permission of eclectic courses enables us to give simultaneously, to different sets of pupils, the ordinary college training in classical studies and the fundamental training of the modern scientific schools; while at the same time there is no marked subdivision between those who follow the old paths and those who choose the new. The same standard of matriculation is established, the same firmness and persistence of application are expected, the same severity of examinations is maintained for all classes of students, and care will be taken that every one who receives the Baccalaureate degree shall be liberally trained in languages, mathematics or some branch of science, the proportion of different studies being left to the choice of the student under the regulation of the Faculty.

Time of Admission.

Informal preliminary examinations may be held from time to time, by mutual agreement between the candidates and the examiners, for the purpose of ascertaining whether a student should be encouraged to present himself for the matriculation examination, and of giving him counsel as to the progress of his studies. To persons at a distance, blank forms of application will be forwarded, upon the return of which, properly filled out, the candidates will be advised as to the expediency of their coming to Baltimore.

Candidates for matriculation residing in Baltimore or in the vicinity are requested to apply for admission on Monday, June 7, 1880, at 9 A. M. It is desirable that notice of the intention to come be given to the President by a note addressed to him in the week previous to the examination.

The next examination for matriculation will be held as follows:

Monday, June 7, 9 A. M., Latin; 3 P. M., Greek.
Tuesday, June 8, 9 A. M., French; 3 P. M., German.
Wednesday, June 9, 9 A. M., Algebra; 3 P. M., Geometry.
Thursday, June 10, 9 A. M., Trigonometry; 3 P. M., Analytical Geometry.

The second examination for matriculation, intended for candidates coming from a distance, will be as follows:

Wednesday, September 22, 9 A. M., Latin; 3 P. M., Greek.
Thursday, September 23, 9 A. M., French; 3 P. M., German.
Friday, September 24, 9 A. M., Algebra; 3 P. M., Geometry.
Saturday, September 25, 9 A. M., Trigonometry; 3 P. M., Analytical Geometry.

The examinations in Algebra and Geometry must be passed, before the candidate offers himself in Trigonometry and Analytic Geometry.

On Saturday, October 2, there will be a special examination i English studies (including United States History and the use o the English Language); and also in Physical Geography or in an branch of Natural Science which the candidate may offer. N matriculation will be considered as completed till these examination are satisfactorily passed.

☞ *There will be no other examination for Matriculation until th close of the first half-year.*

Matriculation.

The special requirements for matriculation are as follows:

Latin. Grammar, Prosody and Composition; ***Cæsar***, 5 books *Ovid*, 2500 verses (500 elegiac); *Virgil*, Æneid, 6 books, and Eclogues *Cicero*, 7 orations; *Livy*, 1 book; *Horace*, Odes, 2 books.

Greek. Grammar, Prosody and Composition; ***Xenophon***, Anabasi 4 books; *Homer*, Iliad, 4 books; *Herodotus*, 1 book; any one dram

Mathematics. *Arithmetic*, including the Metric System; *Algebr* Todhunter, 38 chapters; *Geometry*, Plane and Solid, Chauvenet *Plane Trigonometry*, Chauvenet, 8 chapters; ***Analytic Geometr*** Straight Line and Circle in rectangular coördinates, Salmon (Con Sections) or Howison.

The subjects named, in both Mathematics and Languages, merel indicate the range of the examination. Equivalents are accepted.

The accurate reading at sight of passages previously unseen ma render unnecessary the examination in the books above specified.

Candidates who do not intend to pursue a classical course ma offer German and French instead of Greek.

The equivalent of a minor course in one of these subjects will b expected, and a good elementary knowledge of the other.

SPECIAL EXAMINATION IN ENGLISH STUDIES.—All candidates fo admission will be expected to satisfy the authorities that, in addition t the studies in Mathematics and Languages required for admissio they have been well trained in the ordinary English branches, includin the use of the English language, Geography and United States Histor

SPECIAL EXAMINATION IN NATURAL SCIENCE.—Each candida for admission is expected to offer for examination in some branch o Natural Science. Physical Geography is recommended as within th reach of all. An elementary acquaintance with Botany, Zoölogy o Natural Philosophy is also desirable.

Collegiate Courses.

1. ***Courses of Study.***—Courses of study are arranged fo matriculated students in the following branches:

Scientific.	*Linguistic.*	*Philosophical.*
Mathematics,	Greek,	History,
Physics,	Latin,	Political Economy,
Chemistry,	French,	Psychology and Ethic
Biology.	German,	Logic and Rhetoric.
	English.	

It is not supposed that any student can follow all these course but every one is required to select such a combination as will secur to him a liberal education, founded upon studies in several branche of literature and science. As a rule, each student will have thre courses in progress simultaneously with five weekly exercises in eac A major course will occupy at least two years; a minor cours cannot usually be completed in less than one year.

2. ***Courses Suggested.***—The following combinations are suggested (but not prescribed exclusively) as an aid to students in the selection of their courses for the Bachelor's Degree.

☞ *Whatever course is chosen, a student before graduating must show that he is able to read ordinary French and German at sight.*

He must also give evidence that he can write good English, by presenting for examination and criticism, during the period of his study, five papers suggested by the work he has here been engaged in, and he must follow a course of training in Vocal Culture.

1. CLASSICAL.

For one who wishes a good Classical training:

Marked proficiency in Greek and Latin.

In addition — A Modern Language, one Philosophical and one Scientific course.

2. MATHEMATICAL.

For one who prefers Mathematical studies, with reference to *Engineering, Astronomy, Teaching, etc.:*

Marked proficiency in Mathematics and Physics.

In addition — A Modern Language, Chemistry, and one Philosophical course.

3. SCIENTIFIC.

For one who wishes an education in Scientific studies, not having chosen his specialty:

Marked proficiency in Mathematics and in either Chemistry, Physics, or Biology.

In addition—One other Scientific course, one Philosophical, and one in Language.

4. LITERARY.

For one who wishes a Literary training not rigidly Classical:

Marked proficiency in Romance and Teutonic Languages.

In addition—Latin and any other two courses, one of which must be Scientific.

5. PRELIMINARY TO MEDICINE.

For one who looks towards a course in Medicine:

Marked proficiency in Biology and Chemistry.

In addition—Physics, a Modern Language, and one Philosophical course.

6. PRELIMINARY TO THEOLOGY.

For one who expects to pursue a course in Theology:

Marked proficiency in Greek and Hebrew.

In addition—One Philosophical and two Scientific courses.

7. PRELIMINARY TO LAW.

For one who proposes to study Law:

Marked proficiency in History and Philosophy.

In addition—A Modern Language, and two Scientific courses.

8. PRELIMINARY TO BUSINESS.

For one who is looking forward to a business career, after taking the degree of A. B., and does not propose to continue in an Academic or Professional course.

The arrangements in regard to this course will be announced when they are completed.

3. ***Advisers.***—Each student, who has been admitted as a matriculate or as a candidate for matriculation, is assigned by the President to the special care of some one of the instructors, who is required not only to give all needful counsel and encouragement to the student, but also to keep himself informed of the progress which is being made by the latter in his various lines of work.

4. ***Examples of Major and Minor Courses.***

Mathematics.—The minor course includes: (*a*) Conic Sections and (*b*) Differential Calculus.

The major course requires, in addition to the minor course: (*a*) Spherical Trigonometry, (*b*) Solid Analytical Geometry, *and either* (*c*) Theory of Equations and (*d*) Higher Plane Curves *or* (*e*) Differential Equations. It is expected that those who take Physics also as a major subject will select (*e*), while others take (*c*) and (*d*).

Physics.—The minor course requires a course of lectures and examinations in General Physics during one academic year.

The major course includes, in addition to the minor course: (*a*) work in the Physical Seminary through one year; *and either* (*b*) lectures and recitations in Analytical Mechanics for about half a year, and lectures on some one branch of Mathematical Physics extending through half to three-fourths of a year; *or* (*c*) a prescribed course of reading and examinations.

Chemistry.—The minor course requires: (*a*) experimental lectures on General Chemistry, extending through the academic year; (*b*) laboratory work through half an academic year.

The major course includes, in addition to the minor course: (*a*) laboratory work during half a year; (*b*) an advanced course of lectures on the Chemistry of Carbon Compounds during half a year; (*c*) a course of lectures on Analytical Chemistry during half a year.

Biology. — The minor course extends throughout one year, and includes: (*a*) lectures on General Biology (the fundamental principles of Zoölogy and Botany, as illustrated by the study of selected forms); (*b*) lectures on Osteology; (*c*) lectures on the Embryonic Development of the chick; (*d*) laboratory work on the topics treated of in the lecture courses.

The major course includes in addition to the minor course: (*a*) lectures throughout one year; and (*b*) laboratory work during half a year. Students are allowed to select either Physiology or Comparative Anatomy in the second year.

Greek and Latin.—The minor course in either Greek or Latin requires the study of two authors selected, according to a prepared table, with the approval of the adviser of the student.

For the completion of the major course in either subject, four authors selected from the prepared table are required.

German and French.—In the minor courses students receive such instruction as should enable them to read at sight ordinary French and German, and to render English into French and German, and to understand French and German grammar.

The major courses include the philological study of French and German, their history and relations, and also practice in conversation and composition. Students will not be admitted to the classes in French and German until they have acquired an elementary knowledge of these tongues.

OFFICERS AND INSTRUCTORS, 1879-80.

Trustees.

President.	Treasurer.	Secretary.
Galloway Cheston.	Francis White.	William Hopkins.

George William Brown,
89 W. Chase St.

Galloway Cheston,
815 Madison Ave.

George W. Dobbin,
42 St. Paul St.

John W. Garrett,
50 Mt. Vernon Place.

Charles J. M. Gwinn,
85 Mt. Vernon Place.

Lewis N. Hopkins,
188 St. Paul St.

William Hopkins,
21 Franklin St.

Reverdy Johnson,
Mt. Vernon Hotel.

Francis T. King,
76 Cathedral St.

C. Morton Stewart,
167 Dolphin St.

James Carey Thomas,
317 Madison Ave.

Francis White.
237 St. Paul St.

President of the University.

Gilman, Daniel C. 81 Saratoga Street.

A. B., Yale College, 1852, and A. M., 1855; LL.D., Harvard University, and St. John's College, 1876; Professor in Yale College, 1863-72; President of the University of California, 1872-75.

Professors.

Gildersleeve, Basil L. 253 St. Paul St. *Greek.*

A. B., Princeton College, 1849, and A. M., 1852; Ph. D., University of Göttingen, 1853; LL. D., College of William and Mary, 1869; Professor of Greek in the University of Virginia, 1856-76; Professor of Latin in the University of Virginia, 1861-66.

Martin, H. Newell 233 St. Paul St. *Biology.*

M. B., University of London, 1871, and Dr. Sc., 1872; A. B., University of Cambridge, 1874, and A. M., 1877; Fellow, and late Lecturer on Natural History in Christ College, Cambridge; Fellow of University College, London.

Morris, Charles D. (Collegiate) 158 N. Howard St. *Latin and Greek.*

A. B., Lincoln College, Oxford, 1849, A. M., and Fellow of Oriel College, Oxford, 1852; Professor in the University of New York, 1875-76.

Remsen, Ira 213 St. Paul St. *Chemistry.*

College of the City of New York; M. D., College of Physicians and Surgeons, N. Y., 1867; Ph. D., University of Göttingen, 1870; Professor of Chemistry in Williams College, 1872-76, and previously Assistant in Chemistry in the University of Tübingen.

Rowland, Henry A. 14 Cathedral St. *Physics.*

C. E., Rensselaer Polytechnic Institute, Troy, 1870; Assistant Professor in the same, 1872-75; Ph. D., Johns Hopkins University, 1880.

Sylvester, J. J. 139 St. Paul St. *Mathematics.*

A. M., University of Cambridge: F. R. S., London and Edinburgh; Corresponding Member Institute of France; Member, Academy of Sciences in Berlin, Göttingen, Naples, Milan, St. Petersburg, etc.; LL. D., University of Dublin, University of Edinburgh; late Professor of Mathematics in the Royal Military Academy, Woolwich.

Lecturers.

Gibbs, J. Willard New Haven, Conn. *Mechanics.*

A. B., Yale College, 1858, A. M. and Ph. D., 1863; Professor of Mathematical Physics in Yale College.

Lanier, Sidney 435 N. Calvert St. *English Literature.*

Morris, George S. St. James Hotel. *History of Philosophy.*

A. B., Dartmouth College, 1861, and A. M., 1864; late Professor in the University of Michigan.

Peirce, Charles S. 112 St. Paul St. *Logic.*

A. B., Harvard University, 1859, A. M. and S. B., 1863; of the U. S. Coast and Geodetic Survey.

Rabillon, Leonce 69 Park Avenue. *French Literature.*

Bach. ès Lettres, Université de France, 1832, and Licencié en Droit, 1836.

Trowbridge, John Cambridge, Mass. *Philosophy of Physics.*

S. B., Harvard University, 1865, and S. D., 1873; Assistant Professor of Physics in Harvard University.

Additional for 1880-81.

Diman, J. Lewis Providence, R. I. *History.*

A. B., Brown University, 1851; D. D.; Professor of History in Brown University.

L, A. Graham Washington, D. C. *Phonology.*

Associates.

Adams, Herbert B. 123 W. Madison St. *History*

A. B., Amherst College, 1872, and A. M., 1875; Ph. D., University of Heidelberg, 1876; Lectur on History at Smith College.

Brandt, Hermann C. G. 228 N. Eutaw St. *German*

A. B., Hamilton College, 1872, and A. M., 1875; Assistant Professor of Modern Languages in Hami ton College, 1874-76.

Brooks, William K. Lake Roland, Balt. Co. *Biology*

A. B., Williams College, 1870; Ph. D., Harvard University, 1875; Director of the Chesapeak Zoölogical Laboratory.

Browne, William Hand 2 Huntingdon Ave. *Librarian*

M. D., University of Maryland, 1850.

Cook, Albert S. 123 W. Madison St. *English*

S. B., Rutgers College, 1872, and S. M., 1875.

Cross, John M. 186 St. Paul St. *New Testament Greek.*

A. B., Princeton College, 1867, and A. M., 1870; Tutor of Greek in Princeton College, 1873-76.

Elliott, A. Marshall 214 N. Howard St. *Romance Languages.*

A. B., Haverford College, 1866, and A. M., 1878; A. B., Harvard University, 1868.

Hastings, Charles S. 8 Denmead St. *Physics.*

Ph. B., Yale College, 1870, and Ph. D., 1873; Holder of the "Tyndall Scholarship," in Paris, 187

Lanman, Charles R. 132 W. Madison St. *Sanskrit.*

A. B., Yale College, 1871, and Ph. D., 1873.

Morse, Harmon N. 12 Denmead St. *Chemistry.*

A. B., Amherst College, 1873; Ph. D., University of Göttingen, 1875; Instructor in Chemistry a Amherst College, 1875-76.

Scott, Austin Washington, D. C. *History.*

A. B., Yale College, 1869; A. M., University of Michigan, 1870; Ph. D., University of Leip 1873; late Instructor in History at the University of Michigan.

Story, William E. 41 Franklin St. *Mathematics.*

A. B., Harvard University, 1871; Ph. D., University of Leipsic, 1875; Tutor of Mathematics i Harvard University, 1875-76.

Uhler, Philip R. 218 W. Hoffman St. *Natural History.*

Librarian of the Peabody Institute, and President of the Maryland Academy of Sciences.

Warren, Minton 123 W. Madison St. *Latin.*

A. B., Tufts College, 1870; Ph. D., University of Strasburg, 1879.

Assistants.

Adams, Henry C. 123 W. Madison St. *Political Economy.*

A. B., Iowa College, 1874, and A. M., 1877; Ph. D., Johns Hopkins University, 1878; Lecturer a Cornell University, 1879-80.

Clarke, Samuel F. 267 N. Eutaw St. *Biological Laboratory.*

Ph. B., Yale College, 1878; Ph. D., Johns Hopkins University, 1879.

Craig, Thomas Washington, D. C. *Mathematics.*

C. E., Lafayette College, 1875; Ph. D., Johns Hopkins University, 1878; of the U. S. Coast and Geodetic Survey.

Franklin, Fabian 228 W. Lanvale St. *Mathematics*

Ph. B., Columbian University, 1869; Ph. D., Johns Hopkins University, 1880.

Hall, Lyman B. 255 N. Eutaw St. *Chemical Laboratory.*

A. B., Amherst College, 1873; Ph. D., University of Göttingen, 1875.

Sihler, Christian 100 N. Paca St. *Biological Laboratory.*

Concordia College, 1866; M. D., University of Michigan, 1871

ENUMERATION OF CLASSES

Which have been instructed during the Academic Year 1879-80.

The following lists show the principal classes which have been organized and instructed during the year:

Mathematics. (31 Students.)

Theory of Numbers (8).
Twice weekly, through the year: Prof. Sylvester.

Mathematical Seminary (15).
Once monthly, through the year: Prof. Sylvester and Dr. Story.

Quaternions (4).
Thrice weekly, through the year: Dr. Story.

Elliptic Functions (4).
Thrice weekly, through the year: Dr. Story.

Higher Plane Curves (5).
Four times weekly, first half year: Dr. Story.

Solid Analytic Geometry (4).
Four times weekly, second half year: Dr. Story, assisted by the Fellows in Mathematics.

Differential Equations (8).
Thrice weekly, through the year: Dr. Story.

Calculus of Variations (9).
Twelve lectures: Dr. Craig.

Spherical Harmonics (6).
Twenty lectures: Dr. Craig.

Cylindric or Bessel's Functions (2).
Ten lectures: Dr. Craig.

General Theory of Functions (2).
Thirty lectures: Dr. Craig.

Differential and Integral Calculus (9).
Thrice weekly, through the year: Dr. Franklin.

Conic Sections (3).
Thrice weekly, through the year: Dr. Franklin:—Instruction given chiefly by lectures from notes prepared by Dr. Story.

Theory of Equations (6).
Twice weekly, through the year: Dr. Franklin.

The results of special studies upon the following subjects, among others, have been examined and discussed in the Mathematical Seminary, under the direction of Prof. Sylvester and Dr. Story:

A generalized form of analytical triangle; on vector ratios considered as trigonometric functions of angles; on the condition that a linear total differential equation of the first order in any number of variables may admit of a single primitive; a generalization, for n-fold space, of Euler's equation for polyhedra; a completion of Fermat's theorem; on generalized forms of trigonometric ratios; on volumes and surfaces of n-dimensional spheres; on triangles in- and ex-scribable to a general cubic curve; on binomial congruences; rotation in four-dimensional space; a general method of congruences, and its application to the theory of cyclotomic functions; completion of Wilson's theorem, and on the number of nth residues. Abstracts of these papers have been printed in the University Circulars.

Physics. (38 Students.)

General Physics [Elementary Mechanics, Acoustics and Heat, first half-year; Magnetism, Electricity and Light, second half-year] (15).
Daily lectures and exercises, through the year: Dr. Hastings.

Thermodynamics (6).
Thirty lectures and eight conferences: Prof. Rowland.

Electricity and Magnetism (3).
Twenty lectures and five conferences: Prof. Rowland.

Theory of Heat Conduction (5).
Three lectures and one conference, weekly, second half-year: Prof. Rowland.

Rational Mechanics (10).
Four times weekly, January and February: Prof. Gibbs, of Yale College.

Laboratory Work for Advanced Special Students (10).
Daily, through the year: Prof. Rowland.

Physical Seminary (17).
Saturdays, through the year: Dr. Hastings.

Reading and discussion of current Physical Journals (9).
Once weekly, through the year.

Philosophy of Physics.
Twelve public lectures: Prof. Trowbridge, of Harvard University.

The researches carried on in the Physical Laboratory, by the Fellows and advanced students under the direction of Prof. Rowland, included the following subjects:

The comparison of the electrical resistance with the expansion of a platinum wire at all temperatures up to a white heat; the electric absorption of crystals; the new action of magnetism on an electric current; the determination of the mechanical equivalent of heat by electrical means, using the coil whose absolute resistance was determined here some years ago; the effect of dissolved gases on the expansion of water; the action of magnetism on light; etc.

The work of the Physical Seminary has included: (a)—solution of problems and criticism of results (once weekly, through the year); (b)—five lectures on the laws of probability as applied to the discussion of observations, with examples; (c)—for advanced students, weekly lectures on selected problems in applied mathematics; (d)—problems of various orders of difficulty have been assigned and full reports demanded. A series as complete as possible was framed for those who were striving to meet the requirements of a major course. Other students have given special attention to a particular field—for example, one of the Fellows has devoted his attention largely to electricity and magnetism; another to light (and in one of his reports he has given a new and brief solution of the problem of minimum deviation in the prism, which will be published in the American Journal of Mathematics). One of the special students, by a careful investigation, has determined the equations of the standard meter belonging to the University, thus rendering it useful for the most exact work.

Chemistry. (46 Students.)

General Chemistry (21).
Four lectures by Prof. Remsen, and two examinations by Dr. Morse, weekly, first half-year.

General Chemistry (continued) (9).
Four lectures and two examinations weekly, second half-year: Dr. Morse.

Organic Chemistry (20).
Four lectures weekly, second half-year: Prof. Remsen.

Analytical Chemistry (15).
Once weekly, through the year: Dr. Morse.

Laboratory Work (35).
Four to eight hours daily, through the year: Prof. Remsen and Dr. Morse, and Dr. L. B. Hall.

Reading and discussion of current Chemical Journals (9).
Twice weekly, through the year.

The Fellows and advanced students have also been engaged daily in the laboratory in following out various investigations, mostly under the direction of Prof. Remsen. The principal of these are: On the comparison of sulphonic acids from different sources; sulphoterephthalic acid; sulphoisophthalic acid; the oxidation of nitroxylene; the oxidation of substitution-products of paradiethylbenzene; toluenedisulphonic acid and its derivatives; the oxidation of substitution-products of mesitylene; and the conduct of some unsaturated compounds.

Biology. (32 Students.)

Animal Physiology (11).
Twice weekly, through the year: Prof. Martin.

General Biology (13).
Four times weekly, through the year: Prof. Martin.

Animal Morphology (4).
Four times weekly, first half-year: Dr. Brooks.

Osteology, Human and Comparative (11).
Twice weekly, through the year: Dr. Brooks.

Histology (11).
Special course in Laboratory: Dr. Sihler.

Special Researches in Laboratory (8).
Through the year: Prof. Martin and Dr. Brooks.

Laboratory Instruction, in connection with the lecture courses (23).
Through the year: Prof. Martin, Drs. Brooks, Sihler and Clarke.

Structure, etc., of the Crab and the Oyster.
Three public lectures: Dr. Brooks.

Demonstrations in Physiology to Medical Students (16).
Eighteen lectures with experiments: Prof. Martin.

Practical Instruction in Histology to Medical Students (4).
Eighteen lectures, with laboratory work: Dr. Sihler.

During the year investigations have been carried on in the laboratory on the following subjects, and articles based on them have either been already published or will shortly be:—Influence of stimulation of anterior spinal roots on reflex excitability of the spinal cord; on heat dyspnoea; the influence of quinine on the heart and spinal cord; the nature of the inflammatory changes in keratitis; does a transference of solid particles from maternal to foetal blood take place?; the structure and significance of the gills of Yoldia, Cyclas, and Modiola; the development of Amblystoma punctatum (continued); the embryology of the earth-worm.

During the summer of 1879 the Chesapeake Zoölogical Laboratory for the study of forms of marine life was conducted by Dr. Brooks, with an attendance of ten students. It has been reopened at Beaufort, N. C., for the season of 1880.

Greek. (36 Students)

Pindar (7).
Twice weekly, through the year: Prof. Gildersleeve.

Greek Lyric Poetry (8).
Once weekly, through the year: Prof. Gildersleeve.

Greek Seminary (11).
Twice weekly, through the year: Prof. Gildersleeve.

Greek Composition and Translation (13).
Twice weekly, for three months: Prof. Gildersleeve.

Aeschylus, Sophocles and Euripides (9).
Six readings: Prof. Gildersleeve.

Syntax of Greek Compound Sentence (9).
Second half year: Prof. Gildersleeve.

Greek Tragic Poets.
Nine public lectures: Prof. Gildersleeve.

Aristotle, *Rhetoric* (12).
Thrice weekly, first half year: Prof. C. D. Morris.

Plato, *Gorgias; Meno* (8).
Four times weekly, second half-year: Prof. C. D. Morris.

Homer, *Odyssey* (6).
Four times weekly, first half-year: Prof. C. D. Morris.

Lysias, *Orations, vii, xii, xvi, xxv*; Isocrates, *Orations, i, ix* (6).
Four times weekly, second half-year: Prof. C. D. Morris.

Greek Prose Composition (13).
Once weekly, through the year: Prof. C. D. Morris.

New Testament Greek (8).
Thrice weekly, through the year: Mr. Cross.

New Testament Exegesis (5).
Once weekly, through the year: Mr. Cross.

Exegesis of the Gospels.
Fifteen lectures: Mr. Cross.

Students have privately read for examination:

Aristophanes, *Frogs* (2); *Plutus* (1); *Knights* (1).

Thucydides, *bk. iv* (1); *bks. i, iv* (1); *bk. i* (1).

Demosthenes, *De Corona* (1).

Herodotus, *bks. v ix* (1); *bk. v* (1); *bk. i* (1).

Euripides, *Alcestis* (1); *Hippolytus* (1); *Ion, Bacchae* (2).

Homer, *Odyssey, bks. i-vi* (4); *Iliad, bks. i vi* (2); *Iliad, bks. vii-xii* (2).

During the session of 1879–80, the centre of work in the Greek Seminary was Aristophanes, and the play selected for special study was the *Wasps*. The members of the seminary were required to present in turn an exegetical and critical commentary of a portion of this comedy, and this work constituted a regular weekly exercise. In order to secure a wider knowledge of the author, cursory readings were also instituted in the other plays, which were in like manner assigned to certain students, charged with the duty of preparing the historical introduction and the analysis. In this way nearly all the members of the seminary were made acquainted with the bulk of Aristophanes, and some of them followed besides a course of study in the fragments of the comic poets. Among the more elaborate papers, which were the fruit of this work in Aristophanes, may be mentioned the following: On the Tropology of Aristophanes; on the genitive case in Aristophanes; on the infinitive in Aristophanes; on the distribution of the *choreutai* in the *Wasps*.

Latin. (40 Students.) *Dr. Warren.*

Plautus (13).
Once weekly, through the year.

Historical Latin Grammar (15).
Twelve lectures.

Terence, *Hautontim., Adelphi*; Plautus, *Aulularia* (14).
Four times weekly, first half-year.

Lucretius, *bks. i, iii, iv* (10).
Four times weekly, second half-year.

Horace (18).
Four times weekly, first half-year.

Livy, *bks. xxi, xxii* (18).
Four times weekly, second half-year.

Latin Prose Composition (14).
Once weekly, through the year.

Students have privately read for examination:

Terence, *Eunuchus, Phormio, Andria, Hecyra* (2); *Adelphi Hautontim.* (2); *Hautontim.* (1); *Andria* (1).

Tacitus, *Germania, Agricola* (2); *Historiae, bks. i, ii* (1) *Historiae, bks. ii-v* (2); *Annals, bk. vi* (1).

Juvenal, *Satires* (2).

Plautus, *Mostellaria* (1).

Cicero, *Orator* (2); *de Officiis* (1).

Livy, *bks. ii-vii* (1).

Virgil, *Aeneid, bks. i-xii* (1); *bks. i-vi* (1).

Horace, *Odes, Epodes, Satires, Ars Poetica* (1); *Satir Epistles* (1); *Epodes* (1).

Cæsar, *Civ. Bell.* (1).

Sanskrit. (8 Students.) *Dr. Lanman.*

Hymns of the Rig and Atharva-vedas (1).
Twice weekly, through the year.

Advanced Sanskrit [Kathâ-sarit-sâgara, Proverbs, Veda] (2).
Twice weekly, through the year.

Elementary Sanskrit (5).
Twice weekly, through the year.

The Vedas.
Six public lectures.

German. (60 Students.) *Mr. Brandt.*

Gothic [Ulfila] (2).

Twice weekly, first half-year.

Middle High German [Nibelungenlied] (1).

Once weekly, second half-year.

Middle High German [Minnesinger; Hartmann, *Der arme Heinrich;* Lectures on Grammar and Middle High German Literature] (8).

Twice weekly, second half-year.

German Prose Composition [Essays; Lectures on Historical Grammar; Dictations from English into German] (17).

Once weekly, through the year.

Lectures on German Ballads (17).

Once weekly, October to April.

Goethe, *Faust, i* (14).

Once weekly, April to June.

Lessing, *Nathan der Weise* (14).

Once weekly, first half-year.

Humboldt, *Ansichten der Natur;* Schiller's and Lessing's *Prosa* (10).

Twice weekly, through the year.

Minor Course, Class B, First Division [Bluntschli, *Volkerrecht;* Goethe's and Lessing's *Prosa;* Goethe, *Egmont;* Bernstein, *über Humboldt;* Schiller's Minor Poems; Lectures on comparative study of English and German; Exercises, etc.] (18).

Five times weekly, through the year.

Minor Course, Class B, Second Division [Schiller, *Neffe als Onkel;* Exercises; Grammar] (12).

Thrice weekly, first half year.

Minor Course [Hodges' *Scientific German*] (6).

Twice weekly, second half-year.

Students have read privately for examination:

Schiller, *Wilhelm Tell* (3); *Neffe als Onkel* (1).

Lessing, *Minna v. Barnhelm* (2); *Laoköon* (1).

Goethe, *Prosa* (3).

Humboldt, *Ansichten der Natur* (3).

Scientific German (2).

German, *Minor Poems* (1).

English. (19 Students.) *Mr. Cook.*

Old Saxon [*Heliand*] (2).

Twice weekly, second half-year.

Early English, Advanced Class (1).

Once weekly, second half-year.

Anglo Saxon, Advanced Class (1).

Thrice weekly, first half-year.

Anglo Saxon, Elementary Class (11).

Twice weekly, second half-year.

Chaucer [The Prioresses Tale, Sir Thopas, The Squieres Tale] (4).

Seven expository readings.

Anglo Saxon Laws (5).

Seven recitations.

Shakespeare, Class A (7).

Daily, first half-year.

Shakespeare, Class B (6).

Twice weekly, first half-year.

English Verse, especially Shakespeare's.

Sixteen public lectures: Mr. Lanier.

Romance Languages. (39 Students.)

Romance Dialects (3).

Lectures once weekly, through the year: Mr. Elliott.

Provençal [Girart de Rossilho; Marcabrun; Peire Vidal; Bertran de Born; Folquet de Marseille; Rainbaut de Vaqueiras; Guiraut de Borneil] (3).

Once weekly, through the year: Mr. Elliott.

Wallachian [Alecsandri (Vasile), *Hora de la Plevna; Hora de la Griviţa, La Turnu-Măgurele;* extracts from the writings of Sionu, Alecșandrescu, Boliacu, Muresianu] (3).

Once weekly, through the year: Mr. Elliott.

French, Advanced Course [Chanson de Roland; Lois de Guillaume le Conquérant; Alexandre d'Alberic de Besançon; Garin de Loherain; Amis et Amiles; Guillaume d'Orenge; Renaut de Montauban; Le Roman de Brut (Wace)] (3).

Once weekly, through the year: Mr. Elliott.

French, Major Course [Lectures on the distribution of the Romance Languages; Villehardoin, *La Conqueste de Constantinople; Aucasin et Nicolete;* Adenet Le Roi, *Berte au grand pied;* Marie de France, *Lais, Fables;* Brachet, *Grammaire Historique*] (7).

Twice weekly, through the year: Mr. Elliott.

French, Minor Course, Class A [De Musset, *Un Caprice;* Feuillet, *Roman d'un jeune homme pauvre;* Balzac, *Père Goriot;* Racine, *Plaideurs;* Voltaire, *Mérope;* Molière, *Tartufe;* Translating English into French; Grammars (in French) (Ploetz; Brachet), etc.] (14).

Daily, through the year: Mr. Elliott and Mr. Garner.

French, Minor Course, Class B [Keetels' *Analytical French Reader, pt. ii;* Scribe, *La Bataille de Dames;* De Maistre, *Voyage autour de ma chambre;* Töpffer, *Mésaventures d'un écolier;* Villemain, *Lascaris;* Fiévée, *La Dot de Suzette;* Poetical Selections from Hugo, Lamartine, etc.; Exercises; etc] (10).

Daily, through the year: Mr. Elliott and Mr. Garner.

Scientific French, Saturday Class [Bréal, *Les Idées Latentes du Langage;* Hovelacque, *Notre Ancêtre*] (14).

Once weekly, second half-year: Mr. Elliott and Mr. Garner.

French, Conversation Class (7).

Thrice weekly, through the year: M. Rabillon.

French Epic Poetry, especially the *Chanson de Roland.*

Twelve public lectures in French: M. Rabillon.

French Literature.

Twelve public readings in French: M. Rabillon.

History and Political Science. (33 Students.)

Seminary of American History (15).

Once weekly, two months: Dr. Scott.

Comparative Constitutional History (5).

Once weekly, four months: Dr. H. B. Adams.

History of the Renaissance and Reformation (17).

Daily, first half-year, also ten public lectures: Dr. H. B. Adams.

English Constitutional History, Stubbs' *Select Charters* (15).

Once weekly, six months: Dr. H. B. Adams.

Political Economy (13).

Four times weekly, two months: Dr. H. B. Adams.

Money and Banking (12).

Four times weekly, two months: Dr. H. C. Adams.

National Debts.

Nine public lectures: Dr. H. C. Adams.

Logic. (16 Students.) *Mr. Peirce.*

General Course (14).

Thrice weekly, six months.

Mediaeval Logic (5).

Once weekly, three months.

Probabilities (4).

Once weekly, two months.

Mill's Logic (8).

Once weekly, three months; twice weekly, one month: Mr. Marquand.

History of Philosophy and Ethics. (12 Student
Prof. G. S. Morris.

History of British Philosophy (12).

Three times weekly, second half-year.

German Aesthetics (2).

Once weekly, second half-year.

British Thought and Thinkers.

Twelve public lectures.

Ethics (5).

Once weekly, second half-year.

Classes have also been instructed in Physiography, **Drawing, Elocution,**

SUMMARY OF OFFICERS AND STUDENTS, 1879-80.

President and Professors,	7
Lecturers,	6
Associates,	14
Assistants,	6

ENROLLED STUDENTS.

Graduate Scholars holding Fellowships,	20
Graduate Scholars not holding Fellowships,	*59
Matriculates,	32
Non-Matriculates,	48
TOTAL NUMBER OF SCHOLARS, including the Fellows,	159

* Two of these are absent.

NOT ENUMERATED ABOVE.

Teachers attending a special Class in Early English,	20
Teachers attending a special Class in the Theory of Numbers,	24
Medical Students attending Demonstrations in Animal Physiology,	16
Medical Students attending a Course in Microscopic Anatomy,	4
Persons attending a special Class in Comparative Constitutional History,	6
Persons attending upon the Chesapeake Zoölogical Laboratory,	10
Clergymen attending a weekly Class in New Testament Exegesis,	5

Students in

Mathematics,	31
Physics,	38
Chemistry,	46
Biology,	32
Greek,	36
Latin,	40
German,	60
English,	19
Romance Languages,	39
Sanskrit,	8
History & Political Science,	33
Logic,	16
Philosophy & Ethics,	12

Average Attendance upon Pu
Lectures.

English Verse,
French Epic Poetry,
Biology,
Philosophy of Physics,
Italian Renaissance,
The Vedas,
Greek Tragic Poets,
History of Philosophy,
French Literature,
National Debts,
Average of 10 *courses*,

STUDENTS ENROLLED DURING THE LAST FOUR ACADEMIC YEA

	Graduates, including Fellows.	*Matriculates.*	*Non-Matriculates.*	*Total*
1876-77 . . .	54	12	23	89
1877-78 . . .	58	24	22	104
1878-79 . . .	63	25	35	123
1879-80 . . .	79	32	48	159

SUMMARY OF GRADUATE STUDENTS, 1876-80.

There have been connected with this Institution during the past four years 165 graduate students, including the Fellows.

They came from the following States:

Maine,	1
Vermont,	2
Massachusetts,	13
Connecticut,	2
New York,	15
New Jersey,	7
Pennsylvania,	7
Maryland,	70
(Baltimore, 58)	
District of Columbia,	2
Virginia,	6
North Carolina,	4
South Carolina,	2
Georgia,	1
Mississippi,	1
Louisiana,	1
Ohio,	5
Michigan,	3
Indiana,	2
Illinois,	3
Wisconsin,	2
Iowa,	5
Missouri,	2
Kentucky,	1
Kansas,	1
California,	2
Ontario,	2
Russia,	1
Japan,	2

The Institutions in which they had received their previous training were these:

Amherst College,	7
Bellevue Hospital Medical School (N. Y.),	2
Bonn, University of,	1
Bowdoin College,	2
Brown University,	2
California, University of,	2
Central College (Mo.),	1
Centre College (Ky.),	1
Charleston College (S. C.),	1
Cincinnati, University of,	1
Columbia College,	2
Columbian University,	1
Concordia College,	2
Cornell University,	7
Dartmouth College,	1
Davidson College,	4
Dickinson College,	2
Dickison Seminary,	1
Drew Theological Seminary,	1
France, University of,	1
Furman University (S. C.),	1
Georgetown College (D. C.),	2
Göttingen, University of,	5
Hamilton College,	1
Hampden-Sidney College,	2
Harvard University,	9
Haverford College,	3
Heidelberg, University of,	2
Hillsdale College,	1
Iowa Agricultural College,	1
Iowa College,	1
Johns Hopkins University,	5
Lafayette College,	4
Lehigh University,	1
Leipsic, University of,	3

London, University of,
Marietta College,
Maryland Agricultural College,
Maryland, University of,
Massachusetts Institute of Technology,
Mercer University,
Michigan, University of,
Muhlenberg College,
Norwegian Luther College,
North-Western University (Wis.),
Ohio State University,
Pennsylvania, University of,
Physicians and Surgeons, College of (Balt.),
Princeton College,
Pritchett Institute (Mo.),
Randolph-Macon College,
Rensselaer Polytechnic Institute,
Rochester, University of,
Rutgers College,
South Carolina, University of,
St. John's College,
Stevens Institute of Technology,
Syracuse University,
Tokio, University of (Japan),
Victoria University (Ont.),
Virginia, University of,
Washington College (Md.),
Washington University (Balt.),
Washington and Lee University,
Wesleyan University,
Western Maryland College,
Williams College,
Yale College,

Total, 68.

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

Published here.

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Article I.—Regular Figures in n-dimensional Space. By W. I. STRINGHAM.

A determination of the number of regular figures belonging to n-dimensional space, according to certain assumed criteria. It is shown, in the first place, that there is a tri-group (group of three) of figures belonging to every space, and that their zero-, one-, two-, - - - - and $(n—1)$-dimensional boundaries are all represented, in number, in the successive terms of the three binomial expressions $(1-1)^{n+1}$, $(1—2)^n$, $(2—1)^n$, where n is the dimension of the space; beginning, in the first and second expressions, at the second term, and, in the third expression, at the first term, with zero-dimensional boundaries (*i. e.* summits) and progressing upwards, in regular order. The second and third figures of the tri-group constitute a reciprocal pair, *i. e.* sets of k-dimensional and of $(n—k+1)$-dimensional boundaries are interchanged in the two figures. The first figure is self-reciprocal.

Besides this tri-group, one other regular 4-fold figure is described, viz.: a figure bounded by 24 regular oktahedra; it is self-reciprocal. The length of its edge is shown to be equal to the radius of the circumscribed 4-fold sphere, and hence infinite four-dimensional space may be completely filled up (saturated) with such figures. The aggregate of these is called an infinite 5-fold figure and its reciprocal is another infinite figure and is made up of sixteen-sided regular 4-fold figures (hexadekoids, the third of the tri-group), which also saturate the four-dimensional space.

The criteria used for limiting the number of regular n-fold figures are:

(1) The number of $(n—1)$-fold boundaries which border upon any summit of an n-fold regular figure must be less than the largest number of these boundaries which can be joined together about a point in $(n—1)$-dimensional space.

(2) The number of edges radiating from any summit of a regular n-fold figure must be equal to the number of summits of some one of the regular $(n—1)$-fold figures.

By the application of these criteria the number of regular 4-fold figures is limited to four, viz: the four above referred to. Then by a reapplication of the criteria it is shown that the spaces of dimension higher than the fourth contain only the tri-group of regular figures.

A generalization, for n-fold figures in general, of Euler's equation for polyhedra is also demonstrated. The formula is

$\sum_{k=0}^{k=n} (—)^k N_k — \epsilon = 0$, where N_k is the number of k-fold boundaries, and where ϵ is 2 or 0, according as the space is of an even or odd number of dimensions.

A plate giving illustrations of the conformation of the regular 4-fold figures accompanies the article.

Article II.—On the Algebra of Logic. (To be continued.) By C. S. PEIRCE.

In the *first chapter* the author explains a theory of the mental process of inference caused by peripheral excitations of the nervous system, which are subject to a law, "namely, that they are all adapted to an end, that of carrying belief, in the long run, toward certain predestinate conclusions which are the same for all men. . . . If a given habit, considered as determining an inference, is of such a sort as to tend toward the final result, it is correct; otherwise not. . . . . The passage from the premise to the conclusion takes place according to a habit or rule active within us. . . . . The habit is logically good if it would never (or, in case of a probable inference, seldom) lead from a true premise to a false conclusion; otherwise it is logically bad. . . . . A habit of inference may be formulated in a proposition which shall state that every proposition c related in a given general way to any true proposition p is true. Such a proposition is called the *leading* principle of the class of inferences whose validity it implies. . . . . Logical inferences are not only to be drawn, but also to be subjected to criticism; and therefore we not only require the form P.·.C to express an argument, but also a form, $P_1 \prec C_1$ (read P_1 implies C_1), to express the truth of its leading principle. Here P_1 denotes any one of the class of premises and C_1 the corresponding conclusion. The symbol $\prec$ is the copula, and signifies primarily that every state of things in which a proposition of the class P_1 is true is a state of things in which the corresponding propositions of the class C_1 are true. But logic also supposes some inferences to be invalid, and must have a form for denying the truth of the leading principle. This we shall write $P_1 \overline{\prec} C_1$, a dash over any symbol signifying in our notation the negative of that symbol." On this basis the proposition is identified with the inference, and the term with the proposition. "This identification, by means of which all that is found true of term, proposition, or inference is at once known to be true of all three, is a most important engine of reasoning, which we have gained by beginning with a consideration of the genesis of logic." It is shown that De Morgan's system of eight forms of propositions is "incomplete, and requires to complete it the admission of particularity in the predicate." Various forms of syllogism, dialogism, and immediate inference are developed.

In the *second chapter* the symbols ∞ and 0 for the possible and impossible are introduced, logical addition and multiplication are defined in an original manner, and their laws deduced. A new algebraic method of solving problems in the logic of non-relative terms is explained and exemplified by a well-known problem given by Boole.

The *third chapter* is devoted to the logic of relatives, a branch of the subject to which the author has applied himself for many years with special preference. The sub-titles of this chapter are the following:

§ 1. Individual and Simple Terms. § 2. Relatives. § 3. Relatives connected by Transposition of Relate and Correlate. § 4. Classification of Relatives. § 5. The Composition of Relatives. § 6. Methods in the Algebra of Relatives. § 7. The General Formulae for Relatives.

Article III.—On the General Equations of Electromagnetic Action, with Application to a New Theory of Magnetic Attractions, and to the Theory of the Magnetic Rotation of the Plane of Polarization of Light. By H. A. ROWLAND.

The author treats the subject by first obtaining the general equations for the electric currents and for the magnetic induction in an indefinitely extended medium, using the method of vector potentials. He shows that the equations which connect the electric currents with the electro-motive forces are the same as those which connect the magnetic induction with a quantity which he calls the *magneto-motive force*, which is somewhat similar to the old indefinite idea of *coercive force*. Under these circumstances, the whole magnetic action reduces itself to action between *electro-motive forces* and *magneto-motive forces*, and the elements of *electro-motive force* act on each other like the elements of currents under ordinary circumstances. In order that this shall be so, it is necessary that unclosed electric currents in an indefinite medium shall have no magnetic action, and this is proved by very simple reasoning.

The author then applies his equations to a new physical theory of magnetic and electric action. Suppose a *perfect* fluid to extend throughout space, and suppose electro-motive force to be a tendency to establish vortex rings in this fluid by acting directly on its molecules. Then it can be shown that such a tendency, existing at any one spot in the fluid, will fill the whole of space with these rings packed according to certain laws. The vortices in this fluid are the magnetic force and the *relative* motions of the fluid the electric currents. All magnetic actions of magnets or of electric currents are explained in this way. The theory differs from that of Maxwell by the use of a *perfect* fluid instead of one having the artificial structure of that of Maxwell.

The author then extends his equations to include the action recently discovered by Mr. Hall, and shows that there may be possibly four new constants for each material. Mr. Hall has shown that one of these constants is very small and the author finally considers it probable that only one has an appreciable value, which is the one discovered by Mr. Hall.

Applying the equations thus found to Maxwell's electromagnetic theory of light, it is shown that they indicate very clearly a rotation of the plane of polarization of light. For a ray of light passing in the direction of the axis of z, the equations become

$$
\begin{aligned}
K\mu \left\{ \frac{d^2F}{dt^2} - \frac{c\ c_1}{4\pi\mu} \frac{d^3G}{dt\,dz^2} \right\} - \frac{d^2F}{dz^2} &= 0 \\
K\mu \left\{ \frac{d^2G}{dt^2} + \frac{c\ c_1}{4\pi\mu} \frac{d^3F}{dt\,dz^2} \right\} - \frac{d^2G}{dz^2} &= 0 \\
K\mu \left\{ \frac{d^2H}{dt^2} \right\} &= 0,
\end{aligned}
$$

where F, G, H are the components of the vector potential, K is specific inductive capacity, μ is the magnetic permeability, c_1 is the magnetic force in the direction of z, and c is a constant depending on Mr. Hall's effect. The solution is

$$F = r \cos (nt - qz) \quad \cos mt$$
$$G = r \cos (nt - qz) \quad \sin mt,$$
$$\text{where } m = \frac{\pi K c_1}{2\pi\lambda^2}.$$

The angle of rotation in passing a distance D in the medium, i being the index of refraction, λ_0 the wave length in vacuo and V_0 the velocity of light in vacuo, will be

$$\theta = c\,\frac{\pi}{2\mu V_0}\,\frac{i^2}{\lambda_0^2}\,D\,c_1\left(i - \lambda\,\frac{di}{d\lambda}\right).$$

Using the value of c found by Mr. Hall for gold, this formula gives an amount of rotation very similar to that observed in many bodies. The formula also gives the variation of the rotation with the wave length with great accuracy.

Article IV.—On Certain Ternary Cubic-Form Equations. Excursus B. By J. J. SYLVESTER.

This article includes five titles.

Title 1 contains the theory of the natural derivation of point from point on a general cubic curve.

If P_1 be any such point, x, y, z its co-ordinates, it is shown that a chain or scale of points, P_2, P_4, P_5, P_7, P_8, P_{10}, *ad inf.*, exists on the cubic, whose co-ordinates are rational functions of x, y, z and of the coefficients of the cubic, and which form a closed system in the sense that the tangential to any one of the points and the connective to any two of them (*i. e.* the third point on the cubic collinear with those two) is some other point in the chain. No number which is a multiple of 3 is a sub-index of any of these points, and the law of relation between them is that the tangential of P_i is P_{2i}, and the connective of P_i, P_j is P_k, where k is the sum or difference of i, j; i. e. whichever of these two numbers is not divisible by 3.

It is proved that, if x, y, z are the co-ordinates of P_1, the order in these variables of the co-ordinates of P_k cannot be less than k^2, and ought, for anything that appears to the contrary, to be k^2, the exact proof of the equality being reserved for the last title.

In the *first title*, the cubic being taken under the form $x^3 + y^3 + z^3 + Kxyz$, the simplest expressions are given for the co-ordinates of the connective to *any* two points on a cubic in terms of the co-ordinates of the connected points, which are binomial expressions, viz.; $yzx'^2 - y'z'x^2$; $zxy'^2 - z'x'y^2$; $xyz'^2 - x'y'z^2$, whereas those given by Cauchy are quadrinomial expressions, viz: the 3 minors of

$$\begin{matrix} yz' - y'z & zx' - z'x & xy' - x'y \\ xx' & yy' & zz' \end{matrix}.$$

By virtue of the equation $x'y'z'(x^3 + y^3 + z^3) - xyz(x'^3 + y'^3 + z'^3) = 0$, it is shown that the ratios of these co-ordinates and the simpler ones employed by the author are identical.

Certain algebraico-diophantine equations are shown to be virtually solved by this theory of derivation.

Title 2 contains the theory of the *completed* scale in which every positive number appears as a sub-index, without exclusion of the multiples of 3.

Imagine I to be a point of inflexion and a pencil of rays with I as origin drawn through P_1, P_2, P_4, P_5. P_7, etc., to meet the curve again in P'_1, P'_2, P'_4, P'_5, P'_7, etc.; the latter will constitute a closed system like the former and will resemble it in all essential respects, but the two together will not be closed. Thus P'_1, P_2, will have a connective P_3 which forms a new point. In like manner $P'_1\,P_5$, $P'_1\,P_8$, $P'_1\,P_{11}$, . . will give new points P_6, P_9, P_{12} . . .

If now P'_3, P'_6, P'_9, P'_{12} . . be the opposites (in respect to I) of these new points, the double scale or chain P_1, P_2. P_3, P_4, P_5, P . . .; P'_1, P'_2. P'_3, P'_4, P'_5, P'_6 . . . ad inf., will form a closed system, and the law of squares will continue to hold good for P_k and P'_k, whatever the value of the positive integer k. Thus, *ex. gr.*, if the cubic be taken under the form $x^3 + y^3 + z^3 + Kxyz$; if P_1 is x, y, z, P_2 will be $x(y^3 - z^3)$, $y(z^3 - x^3)$, $z(x^3 - y^3)$, and P_3 will be $y^3z^6 + z^3x^6 + x^3y^6 - 3x^3y^3z^3$, $y^6z^3 + z^6x^3 + x^6y^3 - 3x^3y^3z^3$, $xyz(x^6 + y^6 + z^6 - y^3z^3 - z^3x^3 - x^3y^3)$.

The rule for determining the index of the connective of any two points in the completed scale is then established.

This rule contains a great number of cases, but the universal result is established, that the connective of two points, whether indicated one or both) by an accented or unaccented P, has in all cases a sub-index which is the sum or difference of the sub-indices of the connected points.

Under the *third title*, the law of compound derivation is established, *e.* the law which determines the accent and sub-index of one given derivative of another; the sub-index of the compound derivative i proved to be, in all cases, the product of the sub-indices of the tw from which it springs.

In the *fourth title* the theory of Pertactile or Periodic Poin comes under consideration. These are the points the derivatives which occur in periodic order, the chain or scale of derivation k such points becoming finite and recurrent instead of progressive an infinite.

They are called per-tactile because at each of them a curve of certain order, say the νth order, can be drawn, having with the give cubic a contact of an order one unit higher than at any other poin *i. e.* passing through 3ν instead of only $3\nu - 1$ consecutive points.

Points of inflexion afford the simplest instance of pertactilit namely of 3-point contact with a right line.

Plücker's 27 points follow next in order, the contact of a conic wi the cubic at those points being 6-pointed. In general, if the P_ν to I is a point of inflexion (say I, so that P_1 may be denoted by $I\frac{1}{\nu}$), P_1 or I will be a point at which a curve of the ν^{th} order may be made to pa through 3ν consecutive points. The number of values of $I\frac{1}{\nu}$ is foun in terms of ν.

The problem of the in- and- exscribed k-lateral is reconsidered, a it is shown that in general such polygons separate into perfectly di tinct groups, each group consisting of points denoted by $I\frac{1}{\nu}$ (ν bei always an odd number), and the law for finding the different values ν for a given value of k is made out. Conversely, it is shown th for every odd value of ν, the points denoted by $I\frac{1}{\nu}$ will arrange the selves into a definite number of in- and- exscribed k-laterals. and simple rule is given for finding k in terms of ν. Two short tables a annexed, the first of them giving, up to a certain limit, the differe values of ν corresponding to a given k, and the other the one value k corresponding to a given ν.

Title 5 Contains a rigorous proof of the Law of Squares.

The theorem, being supposed to be true up to a given value, ν, of th index, is easily seen to be true for all even values of the index up 2ν. But to prove the theorem for the odd numbers is much mor difficult and is accomplished as hereunder explained.

Observing that the *unreduced co-ordinates* of the connectives x, y, z; x', y', z' and to y, x, z; x', y', z' have a common third ter the theory of the 1st and 2d titles is employed to prove that these tw sets of co-ordinates, when x, y, z and x', y', z' are derivatives of th same initial point to the indices k, k', cannot have an algebraic factor common to the five distinct terms which belong to them: it i shown that to admit this would lead to the conclusion that a Plückeri point could be a point of inflexion. This is the fundamental lemm of the proof.

Taking now two derivatives of sub-indices $\mu - 1$, μ respectiv (where μ does not exceed ν), calling their co-ordinates x, y, z; x', y', and forming the connectives to x, y, z; x', y', z' and to y, x, z; x', y', whose common unreduced co-ordinate will be $x\,y\,z'^2 - x'\,y'\,z^2$, sa Ω, it will be seen that one of these, a derivative of the sub-index 2μ- will be expressed by co-ordinates, each containing the factor z, and th other of them (which must be either the initial point or its opposit we know must be expressed by co-ordinates whose common factor w be $\frac{\Omega}{z}$. Hence, by the lemma, z can be the only common factor of th other set of co-ordinates, and a very easy arithmetical calculati shows that this is sufficient to prove that the theorem, being true f the sub-indices $\mu - 1$ and μ, is true for the sub-index $2\mu - 1$; hence, true up to ν inclusive, the theorem is true up to 2ν inclusive. Hen it is true universally.

As a corollary, the values of the unreduced co-ordinates are fou resulting from the use of the Cauchyan formulae of the connective any two given derivatives, and it is shown that the method of pro employed would have been inapplicable had those (the quadrinom formulae of connection) been employed instead of those discovered at all events employed) by the author.

American Chemical Journal. Edited by PROFESSOR REMS

Vol. II. No. I. April, 1880.

Article I.—Researches on the Substituted Benzyl Compounds:—T Action of Bromine on Toluol, and some of its Derivatives. By LORING JACKSON and A. W. FIELD.

Some years ago Beilstein, in the course of elaborate investigatio on the action of the halogens on toluene, discovered the fact tha when toluene is treated at ordinary temperatures with chlorine bromine, the halogen enters into the benzene nucleus; whereas, if th action takes place at an elevated temperature, the substitution tak place in the methyl. The authors have now endeavored to define more accurately this law first formulated by Beilstein. They have studied the effects of differences in temperature, and of the addition of iodine, upon the character of the products. Their results are summarized in a few statements made at the end of the paper.

Article II.—On α- and β-Monobromcrotonic Acids. By ARTHUR MICHAEL and LEWIS M. NORTON.

W. Körner endeavored to obtain a monobromcrotonic acid from solid crotonic acid by treating with bromine and subsequently with alkalies. The acid obtained by him has been considered as identical with Kekulè's monobromcrotonic acid obtained by an entirely different method. Other experiments, performed since Körner's, seem to indicate that the results described by him are not correct, hence the authors have reëxamined the subject and have proved that Körner's observations were inaccurate. This paper contains a full account of their method of work.

Article III.—On a new Synthesis of Saligenin. By WM. H. GREENE.

Saligenin is the alcohol corresponding to salicylic alcohol. The author has prepared it from phenol by means of a modification of Reimer and Tiemann's reaction for the preparation of aldehydes from phenols. The method employed consists in treating phenol with methylene chloride and sodium hydroxide in water. The reaction is expressed by this equation:

$$\underset{\text{Phenol}}{C_6H_5 . OH} + \underset{\text{Methylene Chloride}}{CH_2Cl_2} + H_2O = \underset{\text{Saligenin}}{C_6H_4\left\{\begin{array}{l}OH\\CH_2OH\end{array}\right.} + 2HCl$$

Article IV.—On the Decomposition of Alcohols, etc., by Zinc Chloride at high Temperatures. By J. A. LE BEL and WM. H. GREENE.

Certain interesting observations having been made in connection with the action of zinc chloride on amyl alcohol, the authors have extended their experiments to the action of the same substance on other alcohols.

The zinc chloride was strongly heated in a mercury bottle provided with two apertures, through one of which the alcohol was allowed to fall in a thin stream upon the fused zinc chloride. The products of decomposition were then examined.

Among the products obtained from methyl alcohol is hexamethylbenzene.

The decomposition of ordinary alcohol is probably expressed by this equation:

$$2C_2H_6O = C_2H_4O + C_2H_4 + H_2O + H_2.$$

Propyl alcohol yields mainly propylene. Other substances studied were isobutyl alcohol, normal butyl alcohol, aldehyde, acetone and acetic acid.

Article V.—On the Determination of Nitrogen. By S. W. JOHNSON and E. H. JENKINS.

The determination of the amount of nitrogen in agricultural products is one of the principal processes necessary in agricultural experiment stations. The authors have had large experience in this kind of work, and in the present paper they have described in detail the method followed by them. No new principle is introduced, but old principles are so applied as to give the most accurate results in the shortest possible time. It is stated that, by the method described, two and even three analyses may be made in a day. The features which at first invite attention are 1—A mercury pump from ordinary laboratory material for the purpose of extracting the air from the combustion-tube; and 2—A modified form of azotometer for the purpose of collecting and measuring the nitrogen given off in the combustion.

Article VI.—Gum Lac from Arizona. By J. M. STILLMAN.

This paper consists of a description of a resinous substance obtained from Arizona. It occurs in the form of a coating of considerable thickness on the twigs of a plant called "Greasewood." The form of occurrence is precisely the same as that of the gum lac of India.

Article VII.—Ethereal Oil of the California Bay Tree. By J. M. STILLMAN.

Sixty or seventy pounds of fresh leaves from the California Bay Tree (*Umbellaria Californica*) were subjected to the action of steam and 820 grams of oil obtained. This was examined chemically, and found to be allied to the terpenes.

Article VIII.—The Electrolytic Method as applied to Cadmium. By EDGAR F. SMITH.

Some new experiments were undertaken by the author to determine the best conditions for the electrolytic estimation of cadmium. He says the sulphate is to be preferred to any other salt examined for this purpose.

Copper may be separated from cadmium by passing the electric current through the nitric acid solution, when the copper is thrown down and the cadmium left in solution.

Article IX.—Gallium in American Blendes. By H. B. CORNWALL.

The new element discovered by de Boisbaudran has been found in a greyish blende from Friedensville, Pa., and a yellowish brown specimen from Phœnixville, Pa., and there is reason to believe that it is also present in the blendes from Joplin, Mo., Warren, N. H., and Ellenville, N. Y.

Article X.—Nitrification in Standard Ammonium Chloride Solutions. By H. B. CORNWALL.

The statements of different authors, Warrington, Storer, Leeds and Schlösing and Müntz, do not agree in regard to the question whether nitrifaction can take place in the dark or not. As a dilute ammonium chloride solution in use in the laboratory was constantly being made up from a more concentrated solution which had stood for four years in the dark, it became desirable to know whether any change had taken place in the latter solution. Several examinations were made and no evidence of change could be detected.

Article XI.—Laboratory Notes. By WM. L. DUDLEY.

On a Modification of Böttger's Test for Sugar. A New Test for Gallic Acid.

Article XII.—Detection of Hydrochloric Acid by Sulphuric Acid and Acid Potassium Chromate. By H. W. WILEY.

This is a description of a modified form of Fresenius' test, which consists in distilling with sulphuric acid the substance to be examined and then testing for chromium oxychloride.

Article XIII.—On the Oxidation of Substitution Products of Aromatic Hydrocarbons.—V. Experiments in the Para Series. By IRA REMSEN and LYMAN B. HALL.

In this paper, the fifth of the series, the authors describe some experiments undertaken with paraxylene and cymene, with the object of determing the effect of substituting groups upon the oxidizable groups contained in the hydrocarbon. If a negative group, as SO_2NH_2, be introduced into paraxylene, it must, according to the prevalent views, take the ortho position with reference to one of the CH_3 groups. On oxidizing the product, this CH_3 was found to be protected, while the other was oxidized. In cymene there are two oxidizable groups, CH_3 and C_3H_7. The SO_2NH_2 group was introduced into cymene, and taking the ortho position with reference to CH_3, the larger group C_3H_7 is oxidized and the CH_3 protected as in the case of paraxylene. The products are identical in the two cases.

If the product, sulphaminetoluic acid, $C_6H_3\left\{\begin{array}{l}SO_2NH_2\\CH_3\\CO_2H\end{array}\right.$, be further oxidized directly with potassium permanganate, it is converted into sulphoterephthalic acid, $C_6H_3\left\{\begin{array}{l}SO_2OH\\CO_2H\\CO_2H\end{array}\right.$. If, however, the potassium salt of the acid be oxidized, the product is terephthalic sulphinide, $C_6H_3\left\{\begin{array}{l}SO_2NH\\CO\text{—}|\\CO^2H\end{array}\right.$.

Brief Review of the most important changes in the Industrial Applications of Chemistry within the last few years. (Continued.)

In this instalment of his report, Professor Mallet takes up the subject of the *Manufacture of Glass*, and treats of the Materials, the Furnaces, Processes of Glass Working, Annealing of Optical Glass, and the Decoration of Glass Work. Under the heading *Manufacture of Porcelain and other Clay Ware*, the subjects taken up are General Character of Products, Mechanical Appliances, Kilns and Decoration.

Report on Progress in Analytical Chemistry. (Continued.)

This report by Dr. H. N. Morse is a carefully prepared summary of the original papers in analytical chemistry which have appeared in chemical journals this year to date. A very large number of papers has been read in the preparation of the report, and the substance of the more important ones is given.

The remainder of this number is made up of *Notes*, under which appear: *Synthesis of Formic Acid*, by V. Merz and J. Tibiriça; *the Valence of Boron*, by A. Michaelis and P. Becker; *Artificial Alkaloids*, by A. Ladenburg; *On the New Hydrogen Lines and the Dissociation of Calcium*, by H. W. Vogel; *Chlorine, Bromine and Iodine at High Temperatures*, by Victor Meyer and J. M. Crafts; *Brevities.* At the end there is given a list of *Recent Publications relating to Chemistry.*

MEETINGS OF UNIVERSITY SOCIETIES.

Scientific Association.

April 7, 1880.

(1) *A Contribution to the Knowledge of Toluenedisulphonic Acids and on the Constitution of the Alpha-Acid*, by CONSTANTINE FAHLBERG.

This was a description of the results of an investigation which has been in progress for more than a year past. Two isomeric toluenemonosulphonic acids are known. It has now been found that, when a second sulpho-group is introduced into either one of these, the product is the same in the two cases. This fact furnishes the proof of the chemical structure of the disulphonic acid. Certain very peculiar and interesting phenomena were observed in connection with the oxidation of some of the derivatives of the disulphonic acid. These will be fully described in a paper, soon to appear, which will embody the complete results of the investigation.

(2) On *Some Electromagnetic Experiments*, by EDWIN H. HALL.

This communication gave an account of the further progress of experiments referred to in a recent number of the American Journal of Mathematics under the title, "A New Action of the Magnet on Electric Currents."

The effect discovered seemed to be the setting up of an electromotive force at right angles to the primary current and the direction of the magnetic force.

No such *induced* electromotive force appears to be set up in the direction of the magnetic force. It is not yet determined whether the intensity of the primary current can be affected by the action of the magnet. Any such effect, if it exists, is probably exceedingly small and may not lie within reach of the most delicate instruments now in use. A resolute investigation of the matter will probably be made at some not very distant date.

The new effect was first detected in gold, and its direction determined. In silver it is found to have the same direction as in gold, but whether the magnitude is greater or less is not yet known. In iron it is apparently several times stronger than in gold and it has the opposite direction or sign. Nickel, another magnetic substance, shows the effect in a marked degree, and in the same direction as gold. Tin shows a slight effect of the same sign apparently as that in gold.

At Prof. Rowland's suggestion, experiments have been begun for the purpose of testing for a deflection of the lines of statical induction in glass.

Prof. Boltzman, of Gratz, has published in the "*Kaiserliche Akademie der Wissenschaften in Wien*" a method by which he thinks the absolute velocity of the electricity in the gold-leaf strip may be determined from the data afforded by the discovery and observation of the new effect. The assumption upon which his reasoning is based does not seem to be tenable.

(3) *A Preliminary Account of some Experiments tending to prove the Existence of a New Function in the Anterior Roots of the Spinal Nerves*, by H. NEWELL MARTIN.

Sir Charles Ball and Magendie proved that under ordinary circumstances the anterior roots convey alone efferent, and the posterior, afferent nerve impulses.

No difference can, however, be detected between the nerve fibres in each case and it has hence been suspected that they are quite identical, the difference in function depending merely on the different central and peripheral organs attached to their ends. When a motor trunk is stimulated, it is supposed that, in addition to the efferent impulse, which travels from the irritated point to the muscles and makes them contract, there is a centrally traveling impulse, starting at the same time from the same point and reaching the spinal cord, but not manifesting itself there by the production of any detected change. This belief is strengthened by the phenomena of the "action current," but has not been absolutely proved.

This central impulse, if it exists, represents a certain amount of energy and it is a question, What becomes of this? It is probably too small to be detected by physical changes, such as a rise of temperature to which it might give rise; the living animal body being subject to variations which would exceed in amount those produced by transformation of the energy of the nervous impulse; these latter in other words might be expected to fall within the limits of error of the experiment.

It has been long known that the "reflex time" of an animal, such as a frog, is susceptible of modification. If one toe be dipped in very dilute acid it will be withdrawn after a certain interval; but if simultaneously the other foot be crushed or the sciatic trunk of the opposite leg be stimulated, this time is much increased.

Experiments were made with the object of discovering whether the reflex time might not be similarly influenced through the anterior roots alone.

The seventh, eighth and ninth posterior roots of the right side were divided in a frog so as to leave its sciatic trunk communicating with the spinal cord by anterior roots only. The reflex time on the left side was then determined in the above manner. It was found that with simultaneous stimu-ation of the right sciatic it was much increased; the effect coming on slowly d lasting some five or six minutes.

n another case the ninth anterior root was stimulated and the reflex time mated on the leg of the same side. It was greatly prolonged during the stimulation and for a considerable time after its cessation. The experime go to prove that the anterior roots can really conduct impulses centrally a modify the condition of the nerve centres; not arousing sensation or ref movements, but greatly impeding the latter. Whether they also interf with the centrally traveling impulses in posterior roots which tend to ca sensations, has not yet been investigated.

The author stated that this could only be considered as a preliminary co munication, as the difficulty of obtaining bull-frogs at present had made it i possible to perform as yet a sufficient number of experiments to preclude t chance of error. Should the results be confirmed, they would probably ha some pathological importance in throwing light upon the "shock" followi many injuries and surgical operations, for the interference with the cent functions of the cord by impulses reaching it through the motor ro seemed much greater and more enduring than that due to powerful stimulati of the sensory roots. They would also prove, beyond a doubt, that t efferent nerve fibres could convey impulses either way.

May 5, 1880.

(1) *Concerning some Unsaturated Compounds*, by IRA REMSEN.

In this communication, attention was called to some peculiarities of carb monoxide. Some years ago the author showed that this substance does n take up oxygen when treated with ozone at ordinary temperatures, althou it has the formula, CO, and hence must be regarded as unsaturated.

Mr. P. H. Broun has now attempted to determine the temperature which ozone does act upon the monoxide. The experiments have not y been completed, but, from present appearances, it may be said that the acti begins at about 200°, though it takes place very slowly even at a hig temperature. It is believed that at a sufficiently low temperature, carb monoxide will be found to have the formula C_2O_4. It is proposed to test t question in the immediate future.

(2) *Completion of the Theory of Regular Figures*, by WASHINGT I. STRINGHAM.

This paper has been printed in the American Journal of Mathematics, a a synopsis of it is given on page 63 of this Circular.

(3) *A Problem of Morphology, as Illustrated by the Developme of the Earth-worm*, by EDMUND B. WILSON.

The paper gave a brief review of some of the embryological evidence of genealogical connection between the Annelides or higher worms and t Vertebrates, and included an account of the main features of the developme of the earth-worm. Upon comparing the embryology of the bird or Amphi bian with that of an Annelide, such as the earth-worm, a very striking sim larity is apparent in the development of some of the most important system This similarity extends, moreover, to details, so as very strongly to sugge the possibility of a close homology between the corresponding part In both Annelides and Vertebrates the central nervous system aris as two parallel longitudinal thickenings of the outermost embryon layer, or ectoderm. The history of the middle embryonic layer or mes derm is in the earth-worm curiously similar to that of the Vertebrates. T embryonic kidneys of some lower Vertebrates, such as frogs and shark correspond very closely to the excretory organs or segmental tubes of t Annelides. When the development of the Annelides has been carefu studied, we may possibly be led to the conclusion that at a very remo period a group of animals may have existed, which diverged, as time we on, in two directions. One of the branches led to the modern worm the other to the modern Vertebrates.

Philological Association.

April 2, 1880.

(1) On *The Exaggerated Influence of the Septuagint on the Gre of the New Testament*, by JOHN M. CROSS.

The influence of the Septuagint in modifying the Greek of the New Test ment cannot be so great as it is usually considered to be. Many of the s called Hebraisms of the N. T. have no more analogy with the Hebrew tha with Classical Greek. They arose from the desire on the part of the write to emphasize and particularize their statements, the more emphatic being t rule, the unemphatic the exception. This may be seen, *e. g.*, in the extende use of οὐ μή, or of the aorist imperative for the present. Different portion of the Septuagint, amounting to about one-third of the whole, were compare with Paul's Epistles in regard to the use of the preposition *ἐν*. The instance where *ἐν* is used in the Septuagint as a translation of *beth* instrumental, in com parison with its assumed use by Paul, were shown to be about five per cent of the whole amount in the former, and twenty-four per cent. in the latter, result which is a contradiction of the theory on which its Hebraic force i based.

(2) On *The So-called Elliptical Use of the Greek Article*, by FRANCIS G. ALLINSON.

In connection with a conjecture of Winer on Matt. iv. 15, Mr. Allinson pointed out the usage at various periods of the language and showed that this construction, while appearing very strikingly in vivid conversational passages in Lucian, is not found in Classic Greek or in the New Testament, where the ellipsis to be supplied is always a necessary and an easy one. Attention, however, was called to certain passages in Aristophanes which differ from this every-day usage; but the conclusion was reached that neither general classic authority nor that of the New Testament would support the emendation proposed.

(3) *A Note on Horace, Car.* I. xv. 14, by CHARLES D. MORRIS.

"grataque feminis
Inbelli cithara carmina divides."

The different interpretations of *divides* given in the notes of Doering, Dillenburger, Macleane, Orelli, Wickham, Nauck, and Schütz were cited; and as these were all either clearly erroneous, or unsupported by any precise parallel, the suggestion was made that *dividere carmina* might perhaps be intended to indicate an extreme and artificial subdivision of the notes of a melody, suggested in Horace's *sic priscae motumque et luxuriem addidit arti Tibicen.* Though no other example of *dividere*, used in this sense, was adduced, two passages in Shakespeare were referred to (Rom. III., 5. 29 and 1 Hen. iv. III., 1. 211) in which the noun *division* (explained by Schmidt, "variation, modulation") appeared to have a meaning analogous to that claimed for *dividere;* and the rendering *carol*, *trill*, or *quaver* was suggested.

(4) *A Review of Harper's Latin Lexicon*, by MINTON WARREN.

(5) *A brief Communication on Sanskrit Texts recently discovered in Japan*, by CHARLES R. LANMAN.

(6) *A short Statement of the Number and general Character of the American Publications during* 1879 *in the field of Romance Philology*, by A. MARSHALL ELLIOTT.

The whole number of publications was 59, including 2 reprints and 49 translations (from the French). The number of translations in fiction greatly exceeds that in any other subject, amounting to 17 out of a total of 49, the other translations being distributed through nine different departments of literature and science. Eight of the publications were educational, 7 for French and 1 for Spanish. The general character of the educational works is very elementary. No scientific work of any kind appeared in this field during the year.

Mathematical Seminary.

April 21, 1880.

(1) *On a Completion of Wilson's Theorem, and the Number of* n*th Residues*, by OSCAR H. MITCHELL.

Call the number of numbers not greater than k, which contain no other prime factor than a in common with k, the a-totitives of k, and denote the number of them by $\tau_a(k)$. Use the same notation with respect to ab, abc, &c.

If $k = a^t b^{t'} c^{t''} \ldots$, the different totients of k are as follows, viz:

$$\begin{array}{rlllll} \tau(k) = & a^{t-1} b^{t'-1} c^{t''-1} & (a-1) & (b-1) & (c-1) & \ldots, \\ \tau_a(k) = & \text{"} & (-) & (b-1) & (c-1) & \ldots, \\ \tau_{ab}(k) = & \text{"} & (-) & (-) & (c-1) & \ldots, \\ \tau_{abc}(k) = & \text{"} & (-) & (-) & (-) & \ldots, \end{array}$$

&c., for the other combinations of the prime factors of k.

If $k = a^t b^u \ldots l^x \ldots q^z$, $s = ab \ldots l$, and $\sigma = a^t b^u \ldots l^x$, and R_s denote the common $\tau(k)$th power residue of the s-totitives of k, the most general form of Wilson's theorem is as follows:

When $\frac{k}{\sigma}$ *is a power of an odd prime number, or double such a power, or* $= 4$, *and* $\frac{\sigma}{s}$ *is at the same time an odd number, then* $P\tau_s(k) + R_s$ *contains* k*; in all other cases* $P\tau_s(k) - R_s$ *contains* k*;* where $P\tau_s(k)$ denotes the product of all the s-totitives of k. Example: If $k = 60$, and $s = 6$, then $\sigma = 12$; $R_s = 36$, found by solving $x^2 \equiv x$ (mod. 60). Then, $6 \cdot 12 \cdot 18 \cdot 24 \cdot 36 \cdot 42 \cdot 48 \cdot 54 - 36$ contains 60, or $6^8(1 \cdot 2 \cdot 3 \cdot 4)(6 \cdot 7 \cdot 8 \cdot 9) - 36$ contains 60.

The number of roots of $x^n - D \equiv 0$ (mod. a^t), including those not prime to the modulus, is $\sum_{0}^{\delta-1}{}_{(r)}\, \alpha_r a^{r(n-1)} + a^{\theta}$, where $\alpha_r =$ g. c. d. of n and $\tau(a^{t-rn})$, $\theta = E\left(\frac{n-1}{n}t\right)$, and $\delta = t - \theta$. The different terms of the sum express the number of roots for the different values of $D\,a^{nr}$, where $D\,a^{nr}$ denotes an nth residue containing a^{nr}. When $n \geqq t$, the formula becomes $\alpha + a^{\theta}$. If $a = 2$, and $t - rn > 2$, α must be multiplied by 2 when it is greater than unity.

The number of nth residues (mod. a^t) is $\sum_{0}^{\delta-1}{}_{(r)} \frac{\tau(a^t)}{\alpha_r a^{rn}} + 1$. When $n \geqq t$, this is $\frac{\tau(a^t)}{\alpha} + 1$.

If A = the number of nth residues (mod. a^t), and B = the number (mod. $b^{t'}$), &c., then A B, &c., = the number of nth residues (mod. $a^t b^{t'} \ldots$).

(2) *On a General Method in Congruences, and its Application to the Theory of the Divisors of Cyclotomic Functions of every Class, by* ARTHUR S. HATHAWAY.

The *form* f^{-1} (a) may be defined as a solution of the *congruence* $f(x) \equiv a$, and the laws which govern it are the same as if it were defined by the equation $f(x) = a$. Such a quantity, f^{-1} (a), I call *real* (with respect to the modulus) if the parameter a, which is constant only with respect to the modulus, can have a value for which f^{-1} (a) is an integer; otherwise I call f^{-1} (a) *imaginary*. We shall then have that if f^{-1} (a) is real its integral value is a solution of $f(x) \equiv a$, and if it is imaginary $f(x) \equiv a$ is insoluble in integers. These results are independent of the variation of f consequent upon its containing parameters similar to a. When the modulus is a composite number, ϕ^{-1} (a), Φ^{-1} (b), cannot be called *proper* solutions of $[\phi(x) - a][\Phi(x) - b] \equiv 0$ unless they are real; but for a prime modulus, the complete solution of the product is included in the solutions of the factors, and in particular, the congruence has as many solutions real and imaginary together, as its degree, and no more.

A quantity is imaginary if it is imaginary with respect to any factor of the modulus, and it is real if real with respect to the relatively prime factors of the modulus.

Every quantity Σx which satisfies, for the prime modulus p, $\Sigma x^{p^i} \equiv \Sigma x^{p^{i-1}}$ is real with respect to p, and every quantity Σx, which is real for this modulus p, satisfies the congruence $\Sigma x^{p^i} \equiv \Sigma x^{p^{i-1}}$ (mod. p^i). In this theorem the convention is adopted that a quantity is divisible by p when it is a real or imaginary multiple of p. I have corroborated directly this remarkable generalization of Fermat's theorem in the *special* case where the parts of Σx are the roots of a rational integral equation, and I also find that E. Lucas has done the same in Vol. I. Am. Jour. Math. It is upon this theorem that the following propositions are based:

All the roots of unity, and none others, which satisfy $x^{p^i(p-1)} = 1$ are real with respect to p, and those, and none others, which satisfy $x^{p-1} = 1$ are real with respect to p^i.

Take $\Sigma\rho = \rho + \rho^{\lambda 1} + \therefore \rho^{\lambda n}$ where ρ is a primitive root of $x^k = 1$ and 1, $\lambda_1, \ldots \lambda_n$ a set of numbers prime to k which is repeated for the modulus k, when multiplied by any one of the set [*e. g.* 1, 3, 4, 5, 9 mod. 11]. Then $\Sigma\rho$ is real for all positive primes of the form $p^i(p-1)$, $p^i(p-\lambda_1)$, .. $p^i(p-\lambda_n) = \pm \delta k$ and, if k is a prime number, for none others. If $i = o$ $\Sigma\rho$ is real mod. pm.

MR. FRANKLIN, at the March meeting, read a note from Mr. A. W. Whitcom of Milwaukee, stating that the latter had published in the *Analyst*, Vol. 4, p. 138, the theorem on the remainder in Taylor's series, given by Mr. Franklin at a previous meeting.

ERRATUM. Mr. Mitchell has called my attention to the fact that my *Theorem I*, concerning rotation about a plane in four-dimensional space, announced at the March meeting (see page 49), is wrong The word *point* in the theorem should be replaced by the word *axis*. The argument of the proof there given is fallacious and should be cancelled. I give a simple proof of the true theorem, due to Mr. Franklin.

Let the plane be that of $x\,y$, let (a, b, o, o) be the co-ordinates of an *arbitrary* fixed point on it and (x, y, z, u) those of the point which is to rotate about the plane. Then the conditions of the problem give

$$(x-a)^2 + (y-b)^2 + z^2 + u^2 = \text{const.}$$

This is equivalent to

$$x = \text{const.},\ y = \text{const.},$$
$$z^2 + u^2 = \text{const.},$$

which are the equations of a circle.

W. I. STRINGHAM.

SCIENTIFIC PERIODICALS

Published under the auspices of the University.

I. American Journal of Mathematics.

Quarto. Quarterly. Vols. 1 and 2, now complete. Vol. 3, No. 1, in press.

Price, $5.00 per year.

II. American Chemical Journal.

Octavo. Bi-monthly. Vol. 1, now complete. Vol. 2, No. 1, April, 1880.

Price, $3.00 per year.

III. American Journal of Philology.

Octavo. Quarterly. Vol. 1, No. 1 (February 1880). Vol. 1, No. 2 in press.

Price, $3.00 per year.

IV. Studies from the Biological Laboratory.

(Including the papers published by members of the Biological and Zoölogical Laboratories.) Octavo. Vol. 1, now complete.

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SCHEDULE OF SEMI-ANNUAL EXAMINATIONS.

THURSDAY, MAY 27, TO WEDNESDAY, JUNE 9, 1880. HOURS OF EXAMINATION: 9-12 A. M.; 3-6 P. M.

The examinations will be held in Hopkins Hall, unless special notice to the contrary is given by the instructor of any class.

Thursday, May 27.

German Prose Composition: *A. & B.* (23)

Friday, May 28.

General Chemistry. (13)
Plato: *Gorgias, Meno.* (6)
Livy. (17)
Quaternions. (4)

Saturday, May 29.

Analytical Chemistry: *Major Course.* (10)
German: *Minor Course, A.* (13)
French: *Minor Course, B.* (11)
Herodotus, *bk.* i. *(1)
Tacitus: *Historiae, bks.* i, ii. *(1)
Tacitus: *Historiae, bks.* ii-v. *(2)
Tacitus: *Germania, Agricola.* *(2)

Monday, May 31.

Embryology. (10)
French: *Minor Course, A.* (11)
Greek Prose Composition: *A. & B.* (10)
Conics. (3)
Cæsar: *Civ. Bell.* *(1)

Tuesday, June 1.

General Physics (first day). (13)
Advanced Physics. (3)
Lysias: *Orations*, vii, xii, xvi, xxv; Isocrates: *Orations*, i, ix. (4)
Lucretius. (8)
Old French. (2)
Elliptic Functions. (4)
Lessing: *Laoköon.* *(1)
Humboldt: *Ansichten der Natur.* *(1)
Scientific German. *(1)

Wednesday, June 2.

Osteology. (8)
New Testament Greek. (7)
Anglo-Saxon. (10)
German Ballads. (10)
Solid Analytic Geometry. (4)
Homer: *Odyssey, bks.* i-vi. *(2)
Juvenal: *Satires.* *(1)
Euripides: *Alcestis.* *(1)

Thursday, June 3.

Chemistry of Carbon Compounds.
Latin Prose Composition: *B.*
History of British Philosophy.
Differential Calculus.
Cicero: *De Officiis.*
Thucydides, *bk.* iv.

Friday, June 4.

General Biology.
Goethe: *Faust.*
Scientific German.
Theory of Equations.
Aristophanes: *Ranae.*
Virgil: *Æneid, bks.* i-xii.

Saturday, June 5.

Analytical Chemistry: *Minor Course.*
Integral Calculus.
Money, Banking and Finance.
Plautus: *Mostellaria.*
Herodotus, *bks.* v-ix.

Monday, June 7.

General Physics (second day).
Middle High German.
Mill's Logic.
Euripides: *Hippolytus.*
Thucydides, *bk.* i.
Horace: *Satires, Epistles.*

Tuesday, June 8.

Schiller's and Lessing's Prose.
Latin Prose Composition, *A.*
Horace: *Odes, Epodes, Satires, Ars Poet.*

Wednesday, June 9.

Differential Equations.
Conics.

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* Private readings.

BRIEF ANNOUNCEMENTS.

The next number (*Vol. I. No.* 2) of the AMERICAN JOURNAL OF PHILOLOGY, now in press, will contain the following articles: I. *Etymological and Grammatical Notes*, by F. D. ALLEN; II. *Verner's Law*, by H. C. G. BRANDT; III. *Xenophon's Oeconomicus*, by C. D. MORRIS; IV. *French Verbs in* eler *and* eter, by B. F. O'CONNOR; V. *The Last Play in the Tetralogy*, by M. W. HUMPHREYS. It will also contain *Notes and Reviews*, by C. H. TOY, M. W. HUMPHREYS, C. F. RADDATZ, A. M. ELLIOTT, A. S. COOK, T. R. PRICE, etc.

A course of six lectures on the *Theory of Numbers* was begun by DR. W. E. STORY, April 10. None but those who are engaged in teaching or who are preparing to teach are received. This course will be supplemented by two or three lectures, to be given next fall, by PROFESSOR SYLVESTER.

These lectures are designed to give an idea of the properties of integer numbers involved in the processes of arithmetic. Special attention is paid to the following topics: multiplication, determination of the greatest common divisor, prime and relatively prime numbers, and so-called indeterminate equations of the first degree.

HENRY C. ADAMS, A. B., of Iowa College, Ph. D., and late Fellow of this University, has been invited to lecture on Political Economy in the University f Michigan during the next academic year.

The appointment of twenty Fellows for the next academic year will be by the Trustees, June 7, 1880. One hundred and thirty-seven candid have been registered, and their qualifications are now receiving the cons ation of the academic staff. Many of the applicants have not complied the prescribed regulations. The choice is likely to fall on those who presented written papers, exhibiting unusual ability, upon scientifi literary themes.

WALDO S. PRATT, A. B., of Williams College, and now a Fellow of University, has accepted a position, under General Cesnola, in the Metropo Museum of Art, New York City.

WILLIAM BURNEY, S. B., Davidson College, Ph. D., University of Hei berg, now a Fellow of this University, has been appointed Professo Chemistry in the Agricultural College of South Carolina, at Columbia.

The lectures of A. GRAHAM BELL, Esq., on the Science of Phonolog be given after January 1, 1881.

The lectures of PROFESSOR DIMAN, in Modern History, will be g during the month of February, 1881.

Intelligence has been received of the arrival in Europe of PROFES GILDERSLEEVE and SYLVESTER and MR. C. S. PEIRCE.

JOHNS HOPKINS UNIVERSITY CIRCULARS.

Published with the approbation of the Board of Trustees.

No. 6.] BALTIMORE, AUGUST, 1880. [PRICE 5 CENTS.

CALENDAR, FIFTH ACADEMIC YEAR, 1880-81.

September 21.	**Next Term Begins.**
September 22—25.	**Examination for Matriculation.**
September 28.	**Instructions Resumed: Assembly in Hopkins Hall at 8 P. M.**
December 23—January 4.	**Recess.**
February 22.	**Commemoration Day.**
April 14—19.	**Spring Recess.**
June 10.	**Next Term Closes.**

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MEETINGS OF SOCIETIES, Etc.

Scientific. First Wednesday of each month, at 8 P. M. S. F. Clarke, Sec'y.

Historical and Political Science. Third Friday of each month, at 8 P. M. H. B. Adams, Sec'y.

Metaphysical. Second Tuesday of each month, at 8 P. M. Allan Marquand, Sec'y.

Philological. First Friday of each month, at 12 M.

Naturalists' Field Club. Saturday of each week, at 2 P. M.

Biological. Thursday of each week, at 4 P. M.

Mathematical Seminary. Third Wednesday of each month, at 8 P. M.

Greek Seminary. Wednesday of each week, at 12 M.

MATRICULATION EXAMINATION.

The next examination for matriculation will be as follows:

September 22, 9 A. M., Latin: 3 P. M., Greek.

September 23, 9 A. M., French; 3 P. M., German.

September 24, 9 A. M., Algebra; 3 P. M., Geometry.

September 25, 9 A. M., Trigonometry; 3 P. M., Analytical Geometry.

October 2, 9 A. M., English; 3 P. M., Natural Science.

ACADEMIC STAFF, 1880-81.

PRESIDENT.

Gilman, Daniel C. 81 Saratoga St.
A. B., Yale College, 1852, and A. M., 1855; LL. D., Harvard University, and St. John's College, 1876; Professor in Yale College, 1863-72; President of the University of California, 1872-75.

PROFESSORS.

Gildersleeve, Basil L. 253 St. Paul St. *Greek.*
A. B., Princeton College, 1849, and A. M., 1852; Ph. D., University of Göttingen, 1853; LL. D., College of William and Mary, 1869; Professor of Greek in the University of Virginia, 1856-76; Professor of Latin in the University of Virginia, 1861-66.

Martin, H. Newell 233 St. Paul St. *Biology.*
M. B., University of London, 1871, and Dr. Sc., 1872; A. B., University of Cambridge, 1874, and A. M., 1877; Fellow, and late Lecturer on Natural History in Christ College, Cambridge; Fellow of University College, London.

Morris, Charles D. (Collegiate) 158 N. Howard St. *Latin and Greek.*
A. B., Lincoln College, Oxford, 1849, A. M., and Fellow of Oriel College, Oxford, 1852; Professor in the University of New York, 1875-76.

Remsen, Ira 213 St. Paul St. *Chemistry.*
College of the City of New York; M. D., College of Physicians and Surgeons, N. Y., 1867; Ph. D., University of Göttingen, 1870; Professor of Chemistry in Williams College, 1872-76, and previously Assistant in Chemistry in the University of Tübingen.

Rowland, Henry A. 14 Cathedral St. *Physics.*
C. E., Rensselaer Polytechnic Institute, Troy, 1870; Assistant Professor in the same 1872-75; Ph. D., Johns Hopkins University, 1880.

Sylvester, J. J. 139 St. Paul St. *Mathematics.*
A. M., University of Cambridge; F. R. S., London and Edinburgh; Corresponding Member, Institute of France; Member, Academy of Sciences in Berlin, Göttingen, Naples, Milan, St. Petersburg, etc.; LL. D. University of Dublin, University of Edinburgh; D. C. L., University of Oxford; Honorary Fellow of St. John's College, Cambridge; late Professor of Mathematics in the Royal Military Academy, Woolwich.

LECTURERS.

Bell, A. Graham Washington, D. C. *Phonology.*
Ph. D., National Deaf Mute College, 1880.

Craig, Thomas Washington, D. C. *Mathematics.*
C. E., Lafayette College, 1875; Ph. D., Johns Hopkins University, 1878; of the U. S. Coast and Geodetic Survey.

Diman, J. Lewis Providence, R. I. *History.*
A. B., Brown University, 1851; D. D.; Professor of History in Brown University.

Lanier, Sidney 435 N. Calvert St. *English Literature.*

Morris, George S. St. James Hotel. *History of Philosophy.*
A. B., Dartmouth College, 1861, and A. M., 1864; late Professor in the University of Michigan.

Peirce, Charles S. 112 St. Paul St. *Logic.*
A. B., Harvard University, 1859, A. M. and S. B., 1863; of the U. S. Coast and Geodetic Survey.

Rabillon, Leonce 69 Park Ave. *French Literature.*
Bach. ès Lettres, Université de France, 1832, and Licencié en Droit, 1836.

ASSOCIATES.

Adams, Herbert B. 123 W. Madison St. *History.*
A. B., Amherst College, 1872, and A. M., 1875; Ph. D., University of Heidelberg, 1876; Lecturer on History at Smith College.

Brandt, Hermann C. G. 228 N. Eutaw St. *German.*
A. B., Hamilton College, 1872, and A. M., 1875: Assistant Professor of Modern Languages in Hamilton College, 1874-76.

Brooks, William K. Lake Roland, Balt. Co. *Biology.*
A. B., Williams College, 1870; Ph. D., Harvard University, 1875; Director of the Chesapeake Zoölogical Laboratory.

Browne, William Hand 2 Huntingdon Ave. *Librarian.*
M. D., University of Maryland, 1850.

Cook, Albert S. 123 W. Madison St. *English.*
S. B., Rutgers College, 1872, and S. M., 1875.

Cross, John M. 186 St. Paul St. *New Testament Greek.*
A. B., Princeton College, 1867, and A. M., 1870; Tutor of Greek in Princeton College, 1873-76.

Elliott, A. Marshall 214 N. Howard St. *Romance Languages.*
A. B., Haverford College, 1866, and A. M., 1878; A. B., Harvard University, 1868.

Hastings, Charles S. 8 Denmead St. *Physics.*
Ph. B., Yale College, 1870, and Ph. D., 1873; Holder of the "Tyndall Scholarship" in Paris, 1875.

Morse, Harmon N. 12 Denmead St. *Chemistry.*
A. B., Amherst College, 1873; Ph. D., University of Göttingen, 1875; Instructor in Chemistry at Amherst College, 1875-76.

Scott, Austin Washington, D. C. *History.*
A. B., Yale College, 1869; A. M., University of Michigan, 1870; Ph. D., University of Leipsic, 1873; late Instructor in History at the University of Michigan.

Sewall, Henry *Biol*
S. B., Wesleyan University, 1876; Ph. D., Johns Hopkins University, 1879.

Story, William E. 41 Franklin St. *Mathemat*
A. B., Harvard University, 1871; Ph. D., University of Leipsic, 1875; Tutor of Mathemati Harvard University, 1875-76.

Uhler, Philip R. 218 W. Hoffman St. *Natural Hist*
Librarian of the Peabody Institute, and President of the Maryland Academy of Sciences.

Warren, Minton 123 W. Madison St. *La*
A. B., Tufts College, 1870; Ph. D., University of Strasburg, 1879.

ASSISTANTS.

Clarke, Samuel F. 267 N. Eutaw St. *Biol*
Ph. B., Yale College, 1878; Ph. D., Johns Hopkins University, 1879.

Franklin, Fabian 228 W. Lanvale St. *Mathemat*
Ph. B., Columbian University, 1869; Ph. D., Johns Hopkins University, 1880.

Hall, Edwin H. 270 W. Fayette St. *Phys*
A. B., Bowdoin College, 1875; Ph. D., Johns Hopkins University, 1880.

Hall, Lyman B. 255 N. Eutaw St. *Chemist*
A. B., Amherst College, 1875; Ph. D., University of Göttingen, 1875.

Sedgwick, William T. 267 N. Eutaw St. *Biol*
Ph. B., Yale College, 1877.

FELLOWS.

Bevier, Louis *Gre*
A. B., Rutgers College, 1878.

***Bloomfield, Maurice** *Philol*
A. M., Furman University (S. C.), 1877; Ph. D., Johns Hopkins University, 1879.

Bright, James W. *Teutonic Langu*
A. B., Lafayette College, 1877.

Burt, Benjamin C. *Philosoph*
A. B., University of Michigan, 1875, and A. M., 1879.

Freeman, Spencer H. *Phys*
A. B., University of Rochester, 1875, and A. M., 1878.

Hartwell, Edward M. *Biolo*
A. B., Amherst College, 1873, and A. M., 1876.

Kuhara, Mitsuru *Chemist*
S. B., University of Tokio, Japan, 1877.

***Marquand, Allan** *Logic and Eth*
A. B., Princeton College, 1874; Ph. D., Johns Hopkins University, 1880.

Mitchell, Oscar H. *Mathemat*
A. B., Marietta College, 1875, and A. M., 1878.

Mitsukuri, Kakichi *Biolo*
Ph. B., Yale College, 1879.

Nichols, Edward L. *Phys*
S. B., Cornell University, 1875; Ph. D., University of Göttingen, 1879.

Nicolassen, George F. *Gre*
A. B., University of Virginia, 1879

O'Connor, Bernard F. *Romance Langu*
Bach. ès Lettres, Université de France, 1874.

Palmer, A. Chase *Chemist*
A. B., Johns Hopkins University, 1879.

Perry, Herbert M. *Mathemat*
A. B., Harvard University, 1880.

Prentiss, Robert W. *Mathemat*
S. B., Rutgers College, 1878.

Rowland, William L. *Chemist*
S. B., University of Pennsylvania, 1880.

Spieker, Edward H. *Gre*
A. B., Johns Hopkins University, 1879.

Swift, Morrison I. *Philosoph*
A. B., Williams College, 1879.

Van Velzer, Charles A. *Mathemat*
S. B., Cornell University, 1876.

Wheeler, Arthur W. *Phys*
A. B., Amherst College, 1879.

Wilson, Edmund B. *Biolo*
Ph. B., Yale College, 1878.

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*Fellows by courtesy.

COURSES OF INSTRUCTION FOR THE FIFTH ACADEMIC YEAR.

PRELIMINARY PROGRAMMES.

The following Announcements should be read in connection with the Register for 1879-80, to which they are in part supplementary.

In this Register will be found a full statement of the work performed last year by the University, Collegiate and Special Students, the terms of Graduation, Fees, Calendar, Major and Minor Courses, etc. Copies may be obtained on application by postal card to the Johns Hopkins University.

The statements now given are to be considered as preliminary to fuller subsequent announcements to be made orally or in writing by the several departments.

Students who desire additional information, especially those who propose to enter here in the Autumn, are requested to correspond with the President.

Mathematics.

1. Professor SYLVESTER will lecture three times a week through the year on the *Theory of Numbers*. The advanced course will occupy one hour weekly, and the elementary course two hours weekly.

2. A *Mathematical Seminarium* will be conducted by Professor SYLVESTER and Dr. STORY.

At its monthly meetings, which are attended by all the instructors and advanced students of mathematics, papers are read, and such topics are freely discussed as may have been suggested in the reading of the professors and students, or may be, for other reasons, of interest to the company.

3. Dr. W. E. STORY, Associate in Mathematics, will lecture as follows:

(a) On *Higher Plane Curves*, an advanced course, twice a week, and an elementary course, four times a week, during the first half-year.

(b) On *Solid Analytic Geometry*, an advanced course, twice a week, and an elementary course, four times a week, during the second half-year.

(c) On *Differential Equations*, two or three times a week, during the year.

4. Dr. THOMAS CRAIG (of the United States Coast and Geodetic Survey) will lecture four times a week through the year:

(a) On the *Theory of Functions*, including the Abelian.

(b) On the *Theory of Fluid Motion*.

5. Mr. C. S. PEIRCE (of the United States Coast and Geodetic Survey) will lecture during the last half-year on the *Theory of Probabilities*.

6. Dr. FABIAN FRANKLIN, Assistant in Mathematics, will instruct classes, during the year, in

(a) *Conic Sections*, three hours weekly.

(b) *Differential and Integral Calculus*, three hours weekly.

(c) *Determinants and Modern Algebra*, two hours weekly.

Physics.

1. The *Physical Laboratory*, well equipped with instruments (especially with reference to researches in Heat, Electricity and Magnetism), is constantly open to advanced students, under the direction of Professor ROWLAND, from 9 A. M. to 5 P. M.

2. Professor ROWLAND will lecture through the year on *Thermodynamics* and the *Mathematical Theory of Magnetism and Electricity*.

3. Dr. C. S. HASTINGS, Associate in Physics, will give the instruction in *General Physics* (including Mechanics, Light, Sound, Heat, Electricity and Magnetism). There are daily exercises, through the year, including two lectures, three recitations, and one practical lesson in the Laboratory, (to which a select number of students is admitted), weekly.

To enter this class, a knowledge of Trigonometry is essential.

[For more detailed information in respect to the work in Mathematics and Physics, consult *University Circular, No.* 3 (February, 1880), which will be sent to students proposing to pursue these courses.]

Chemistry.

1. The *Chemical Laboratory*, a new and well arranged building, thoroughly equipped, is open daily from 9 A. M. to 5 P. M. The work of advanced students is under the direction of Professor REMSEN, (who is in the Laboratory for consultation during the regular working hours), and he will also, with the coöperation of Dr. H. N. MORSE, Associate in Chemistry, direct the general laboratory work.

2. Lectures on *General Chemistry* will be given, four times a week, during the first half-year by Professor REMSEN, and, during the last half year by Dr. MORSE, with two examinations weekly.

3. Lectures on *Organic Chemistry* will be given by Professor REMSEN, four times a week, during the second half-year.

4. Lectures on *Analytical Chemistry* will be given once a week by Dr. MORSE, through the year.

Biology.

1. The *Biological Laboratory*, which contains an unusually complete collection of physiological instruments, is constantly open, under the direction of Professor MARTIN. Instruction is given to advanced students, and also to those who desire a knowledge of Biology as introductory to the study of medicine, or as a branch of a liberal education.

2. The *Chesapeake Zoölogical Laboratory* is open for the present year, during the warmer months, at Beaufort, N. C., under the direction of Dr. W. K. BROOKS, Associate in Biology. It is a station for the prosecution of original researches in respect to the marine life of the Atlantic sea-board, and advanced students only are received.

3. Lectures are given, through the year, by Professor MARTIN on *General Biology*, and on *Animal Physiology*.

4. Lectures will be given, during the Winter months, by Dr. W. K. BROOKS, on *Animal Morphology*.

5. Instruction will be provided in *Vegetable Physiology* and *Morphology*.

Greek and Latin.

1. A *Greek Seminarium* will be conducted by Professor Gildersleeve, and will meet twice weekly through the year. Its object is to train the future teacher in the exegesis and criticism of Greek authors, and to guide individual research on all the lines of philological inquiry, grammatical, literary, historical, and archæological.

The studies are grouped each year about some organic centre. In 1878–79 the exercises consisted in the analysis, exegesis and criticism of selected tracts of Lucian, and in the prosecution of researches into the language of Lucian, and the life of the second century. During the session of 1879–80 the centre of work was Aristophanes. In 1880–81 the study of the *Attic orators and the Greek rhetoricians* will form the chief occupation of the members.

2. Professor Gildersleeve will lecture on *Greek Grammar, especially Syntax*, once a week, for three months, and then, twice a week, through the year. He will also conduct a series of practical exercises (at least twenty) in *Greek Composition* and in translating Greek at dictation, and will interpret select *Tracts of the Greek Renaissance;* and will read some Greek poet (to be announced).

3. Dr. M. Warren, Associate in Latin, will form a class, to meet at least once a week, for the critical study of *Terence*. Each member will be supposed to have an acquaintance with all the plays of Terence, and attention will be directed more especially to the critical constitution of the text, and a discussion of the views of different commentators. Students are recommended to get Umpfenbach's edition with critical apparatus.

He will conduct a course of reading in the *Latin Rhetoricians*, especially Cornificius (Rhetorica ad Herennium), Quintilian and Seneca the father), and also a series of exercises, in the latter part of the year, in the interpretation of *Latin Inscriptions*.

4 In the major and minor courses (chiefly arranged for undergraduates, but open also to others), it is proposed that the following authors shall be read under the direction of Professor C. D. Morris and Dr. M. Warren:

In Latin.

Horace, Odes, Epodes, Satires, Epistles. *Livy*, three books (probably not xxi). *Tacitus*, Germania, Agricola, Dial. de Or, and parts of the Annals. *Plautus*, two plays. *Terence*, one play.

If arrangements can be made, the Verrian orations of *Cicero* will also be read.

In Greek.

Herodotus, books iii. and iv. *Sophocles*, Antigone and Electra. *Thucydides*, books iv. and v. *Euripides*, two plays, not yet selected

There will besides be weekly exercises in Greek and Latin composition throughout the year.

5. Mr. J. M. Cross, Associate in New Testament Greek, will give instruction in the principles of textual criticism, and will read selected portions of the *Greek New Testament*, with reference to the dialectic and individual characteristics of the writers.

Romance and Teutonic Languages.

1. Mr. A. M. Elliott, Associate in Romance Languages, offers instruction to advanced students in *Old Italian Dialects* (Mommsen, Die unteritalischen Dialecte); *Low Latin* (Meyer, Recueil d'anciens textes bas-latins); *Provençal* (Arnaut Daniel, Raimon de Miraval, Peire Cardenal); *French of the Twelfth Century;* and *Portug* (Camões, Os Lusiadas).

He will also direct a second class in *Old French* (from the Nint the Twelfth Century); *Italian* (Dante, Divina Commedia); *Spanish* (Poema del Cid).

He will also lecture during the year on the French, Spanish Italian Dialects.

The major and minor courses in French will be carried o heretofore.

2. Mr H. C. G. Brandt, Associate in German, offers instruc to advanced students in *Gothic* (Bernhardt's text and the gramma Heyne's edition of Stamm's Ulfilas); in *Old High German* (Brau Althochdeutsches Lesebuch, Hahn's Grammatik, Piper's Ot Althochdeutsche Versbetonung); in *Middle High German*, (Ni lungenlied, Bartsch's edition), selections from the Minnesin Weinhold's Grammatik.

He also proposes to conduct a *German Seminarium*, once a w or once in two weeks, in which the literary work will turn chi upon the ante-classical period (from 1725 to the death of Lessi Goethe's Faust, and the Lyrics of Schiller and Goethe; while grammatical and philological work will include the historical comparative grammar of the Teutonic Languages.

The major and minor courses in German will be continued heretofore.

3. Mr. A. S. Cook, Associate in English, will instruct in *An Saxon, Early and Later English.* The courses will be in substa those which have hitherto been announced; but a more expl statement will be made at a later day.

4. Mr. L. Rabillon, Lecturer on French Literature, will g public courses of lectures, *in French*, and will meet, in a private c students who wish to perfect themselves in the use of oral and writ French.

5. Mr. Sidney Lanier, Lecturer on English Literature, will lect in public on topics to be hereafter announced.

History and Political Economy.

1. Dr. H. B. Adams, Associate in History, will give a general cou of instruction in *Modern History*, particularly with reference *Modern Absolutism and Revolution*, four hours a week, during early part of the year; and also a special course, once a week, on sources of early *English Constitutional History.*

He will also lecture in public on the History of the Mediæval Chu and State.

2. Dr. A. Scott, Associate in History, will give a course of instr tion in *American Constitutional History.*

[Further information in respect to the major and minor courses History may be had, in print, on inquiry.]

Philosophy and Logic.

Professor G. S. Morris will lecture during the last half of the y on *Systematic Ethics* and on some phases of the *History of Anci Philosophy.*

Mr. C S. Peirce will lecture on the *Theory of Probabilities* a on other topics in Logic.

SCIENTIFIC PERIODICALS

Published under the auspices of the University.

I. **American Journal of Mathematics.**

Quarto. Quarterly. Vols. 1 and 2, now complete. Vol. 3, in progress. Price, $5.00 per year.

II. **American Chemical Journal.**

Octavo. Bi-monthly. Vol. 1, now complete. Vol. 2, Nos. 1, 2, 3, issued. Vol. 2, No. 4, in press. Price, $3.00 per year.

III. **American Journal of Philology.**

Octavo. Quarterly. Vol. 1. Nos. 1, 2, issued. Vol. 1, No. 3, in pre

Price, $3.00 per year.

IV. **Studies from the Biological Laboratory.**

(Including the papers published by members of the Biological a Zoölogical Laboratories.) Octavo. Vol. 1, now complete.

Price, $3.50 per volume.

JOHNS HOPKINS UNIVERSITY CIRCULARS.

Published with the approbation of the Board of Trustees.

No. 7. BALTIMORE, DECEMBER, 1880. PRICE 5 CENTS.

CALENDAR, 1880-81.

September 21.	**Fifth Academic Year Began.**
September 28.	**Instructions Resumed.**
December 23—Jan. 4.	**Christmas Recess.**
February 22.	**Commemmoration Day.**
April 14—19.	**Spring Recess.**
June 10.	**Term of Instruction Closes.**

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MEETINGS OF SOCIETIES, Etc.

Scientific. First Wednesday of each month, at 8 P. M. Next meeting, January 5. E. H. Hall, Sec'y.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, December 17. H. B. Adams, Sec'y.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, December 14. Allan Marquand, Sec'y.

Philological. First Friday of each month, at 12 M. Next meeting, January 7. M. Warren, Sec'y.

Mathematical. Third Wednesday of each month, at 8 P. M. Next meeting, December 15.

PUBLIC LECTURES.

Prof. Rabillon's Course (in French) on the *Satirists of France* is now in progress in Hopkins Hall, at 5 P. M, on Wednesdays and Saturdays of each week.

A full announcement of the other lectures to be given this year will be made in the next number of the these Circulars.

ENUMERATION OF CLASSES, FIRST HALF-YEAR, 1880-81.

Mathematics. (27 Students.)

Classes meet in Room 16.

Theory of Numbers: Prof. Sylvester. Twice weekly, Tuesday and Friday, 1 P. M. (6).

Franklin.
Hathaway.
Ladd.
Mitchell.
Prentiss.
Van Velzer.

Mathematical Seminary: Prof. Sylvester and Dr. Story. Third Wednesday of each month, 8 P. M. (14.)

Bissing.
Bland.
Collins.
Cuykendall.
Franklin.
Freeman.
Hathaway.
Ladd.
Mitchell.
Norwood.
Perry.
Pickle.
Prentiss.
Van Velzer.

Problems in Mathematics: Dr. Story. Once weekly, Thursday, 12 M. (4).

Bissing.
Collins.
Norwood.
Prentiss.

Higher Plane Curves: Advanced Course: Dr. Story. Twice weekly, Tuesday and Friday, 10 A. M. (4).

Ladd.
Mitchell.
Norwood.
Prentiss.

Conic Sections: Dr. Story. Thrice weekly, Monday, Wednesday and Friday, 1 P. M. (8).

Collins.
Cuykendall.
Day, W. C.
Garthe.
Gilman, B. I.
Keeler.
Liebig.
Reese, C. L.

Theory of Functions: Dr. Craig. Thrice weekly, Tuesday, Thursday and Friday, 5 P. M. (3).

Bissing.
Mitchell.
Van Velzer.

Hydrodynamics: Dr. Craig. Twice weekly, Tuesday and Thursday, 4 P. M. (6).

Bissing.
Goodnow.
Hall.
Perry.
Prentiss.
Wheeler.

Determinants: Dr. Franklin. Twice weekly, Monday and Wednesday, 10 A. M. (9).

Bissing.
Collins.
Fletcher.
Freeman.
Gilman, B. I.
Hall.
Norwood.
Perry.
Wheeler.

Differential Calculus: Dr. Franklin. Thrice weekly, Monday, Wednesday and Friday, 11 A. M. (6).

Collins.
Cuykendall.
Harlan.
Koyl.
Page.
Pickle.

Theory of Equations: Dr. Franklin. Twice weekly, Tuesday, 12 M., and Thursday, 10 A. M. (5).

Collins.
Cuykendall.
Garthe.
Pickle.
Reese, C. L.

Physics. (32 Students.)

Classes meet in Rooms 3, 4, 7, 8.

General Physics: Dr. Hastings. Daily, 10 A M. (15).

Adkins.
Berry.
Boston.
Day, D. T.
Earle.
Ebeling.
Ingle.
Johnson.
Page.
Price.
Robinson, A. J.
Robinson, C. H.
Stratton.
Wiegand.
Wilson, H. V.

Additional attendants upon Experimental Lectures.

Collins.
Harlan.
Pickle.

Laboratory Work: Professor Rowland. Daily, 9 A. M. to 5 P. M. (6 advanced students.

Barnett,
Fletcher,
Freeman,
Goodnow,
Koyl,
Wheeler,

Electricity and Magnetism: Prof. Rowland. (6).

Fletcher.
Freeman.
Goodnow.
Koyl.
Perry.
Wheeler.

Major Course: Dr. Hastings. Lectures once weekly, Thu
1 P. M.; Laboratory work during week, especially Wednesday
noon. (8).

Bissing.
Coale.
Collins.
Cuykendall.
Day, W. C.
Harlan.
Liebig.
Pickle.
Prentiss.
Reid.

Laboratory Work: (*Class in General Physics*). Dr. Has
(12).

Boston.
Broun.
Day, D. T.
Earle.
Ebeling.
Johnson.
Page.
Price.
Robinson, C.
Stratton.
Wiegand.
Wilson, H. V

Chemistry. (33 Students.)

Classes meet in Chemical Laboratory.

General Chemistry: Four lectures by Prof. Remsen, an
examinations by Dr. Morse, weekly, (including Saturday), 9
(22).

Baden.
Bayley.
Dosh.
Earle.
Freeman.
Frick.
Garthe.
Keeler.
Keyser.
Kimball.
Liebig.
Mahon, O. L.
Marburg.
Price.
Robinson, C. H.
Rolando.
Stevens.
Stratton.
Thomas.
Trimble.
Warren, H. C
Wiegand.

Laboratory Work: Prof. Remsen and Dr. Morse. Daily.

Baden.
Bayley.
Broun.
Coale.
Clark, B.
Day, D. T.
Day, W. C.
Dosh.
Earle.
Frick.
Garthe.
Goldsborough.
Keeler.
Keyser.
Kimball.
Kuhara.
Liebig.
Mahon, O. L.
Mahon R. W.
Marburg.
Palmer, C.
Palmer, A. G.
Pund.
Robinson, C.
Stevens.
Stokes.
Stratton.
Thomas.
Trimble.
Warren, H. C
Wiegand.
Worthington.
Wylie.
Young.

Analytical Chemistry: Dr. Morse. Three times weekly,
day, Thursday and Friday, 10 A. M. (7).

Dosh.
Keyser.
Palmer, A. G.
Pund.
Stevens.
Thomas.
Trimble.

Biology. (20 Students.)

Classes meet in Biological Laboratory and Lecture Room.

Animal Physiology: Prof. Martin. Thrice weekly, Mo
Wednesday and Friday, 11 A. M. (12).

Donaldson.
Dosh.
Hartwell.
Howell.
Keyser.
Lockwood.
Mitsukuri.
Moale.
Reid.
Rolando.
Warfield.
Wilson, E. B.

General Biology: Prof. Martin. Thrice weekly, Tue
Thursday and Saturday, 11 A. M. (7).

Lockwood.
Mitsukuri.
Moale.
Reid.
Stevens.
Trimble.
Warfield.

Human Anatomy: Dr. Winslow, Univ. of Md. Thrice we
Tuesday, Thursday and Saturday, 1.15 P. M. (3).

Donaldson.
Howell.
Rolando.

Romance Languages. (26 Students.)

Low Latin: *P. Meyer's Receuil d'anciens textes bas-latins:* MR. ELLIOTT. Once weekly, Friday, 5 P. M., Room C. (4).

Fay.
Garner.
O'Connor.
Taylor, P. H.

Portuguese: *Camões, Os Lusiadas:* MR. ELLIOTT. Once weekly, Friday, 3 P. M., Room C. (3).

Fay.
Garner.
O'Connor.

Provençal: *Gaucelm Faidit, Arnaut Daniel:* MR. ELLIOTT. Thrice weekly, Monday and Wednesday, 11 A. M., and Friday, 4 P. M., Room C. (4).

Fay.
Garner.
O'Connor.
Taylor, P. H.

Italian: *Dante:* MR. ELLIOTT. Twice weekly, Monday and Wednesday, 12 M., Room C. (6).

Baden.
Brinton.
Liebig.
Linthicum.
O'Connor.
Reese, R. M.
Taylor, P. H.

Old French: MR. MARCOU. Thrice weekly, Tuesday, Thursday and Friday, 12 M., Room C. (2).

Baden.
Gordon.
Reese, R. M.
Taylor, P. H.

French: *Minor Course:* MR. MARCOU. Daily, 1 P. M., Room C. (8).

Bowdoin.
Brown.
France.
Glenn, W. L.
Gordon.
Jones.
Miller.
Wilson, H. V.

French: *Reading Class:* MR. MARCOU. Once weekly, Thursday, 11 A. M., Room I. (10).

Baden.
Beadenkopf.
Boston.
Dosh.
Duffy.
Garthe.
Robinson, C. H.
Warfield.
Wiegand.
Wilhelm.

English. (22 Students.)

Anglo-Saxon: MR. COOK. Twice weekly, Tuesday and Friday, 11 A. M., Room B. (2).

Alexander.
MacClintock.

Icelandic: MR. COOK. Thrice weekly, Monday, Wednesday and Thursday, 11 A. M., 123 W. Madison street. (2).

Bright.
Gjellum.

Shakespeare: MR. COOK. Daily, 3 P. M., Room B. (6).

Boyle.
Cheek, F. J.
Cheek, S. R.
Day, D. T.
Evans.
MacClintock.

Prose Style: MR. COOK. Once weekly, Saturday, 12 M., Room A. (14).

Bemis.
Campbell.
Earle.
Ebeling.
Fels.
Jones.
MacClintock.
Marburg.
Nicolassen.
O'Connor.
Ramage, B. B.
Ramage, B. J.
Thach.
Wilhelm.

History and Political Science. (38 Students.)

Modern Absolutism and Revolution: DR. H. B. ADAMS. Four times weekly, Monday, Tuesday, Thursday and Friday, 4 P. M., Room A. (33).

Adkins.
Bemis.
Berry.
Bowdoin.
Boyle.
Brinton.
Campbell.
Cheek, F. J.
Crisp.
Derby.
Ebeling.
Evans.
Fels.
France.
Gordon.
Ingle.
Jameson.
Johnson.
Kimball.
Leftwich.
Mahon, O. L.
MacClintock.
McIlwaine,
Murray.
Patterson,
Peterson.
Ramage, B. B.
Ramage, B. J.
Robinson, A. J.
Sale.
Swift.
Tiffany.
Wilhelm.

English Constitutional History: ***Stubbs's Select Char***
DR. H. B. ADAMS. Once weekly, Wednesday, 12 M., small lec
room of the Peabody Institute. (13).

Bemis.
Berry.
Crowe.
Derby.
Campbell.
Fels.
France.
Ingle.
Jameson.
Leftwich.
Ramage, B. B.
Ramage, B. J.
Tiffany.

History of Local Self-Government: DR. H. B. ADAMS. (
weekly, Saturday, 10 A. M., Library of the Maryland Histo
Society. (30).

Adkins.
Bemis.
Berry.
Bowdoin.
Boyle.
Brinton.
Campbell.
Cheek, F. J.
Crisp.
Crowe.
Derby.
Ebeling.
Evans.
Fels.
France.
Gephart.
Goodman.
Jameson,
Johnson.
Kimball.
Leftwich.
Linthicum.
Mahon, O. L.
McIlwaine.
Murray.
Palmer, N.
Ramage, B. B.
Ramage, B. J.
Robinson, A.
Wilhelm.

Political Economy: DR. H. C. ADAMS. Four times weekly,
day, Tuesday, Thursday and Friday, 5 P. M., Room B. (17).

Adkins.
Bemis.
Brinton.
Campbell.
Jameson.
Johnson.
Leftwich.
Linthicum.
McIlwaine.
Mahon, O. L.
Murray.
Palmer, N.
Ramage, B. B.
Ramage, B. J.
Robinson, A.
Swift.
Tiffany.
Wilhelm.

Finance: DR. H. C. ADAMS. Once weekly, Wednesday, 4 P.
Room A. (15).

Adkins.
Bemis.
Brinton.
Campbell.
Jameson,
Johnson.
Kimball.
Leftwich.
Linthicum.
McIlwaine.
Mahon, O. L.
Murray.
Palmer, N.
Robinson, A.
Tiffany.
Wilhelm.

In addition to the above classes, a meeting is held once weekly, Wedne
5 P.M., in room A, for the discussion of special themes in Political Econom

Logic and Psychology. (13 Students.)

Advanced Logic: MR. PEIRCE. Thrice weekly, Tuesday, T
day and Friday, 9 A. M., Room C. (7).

Bissing.
Franklin.
Gilman, B. I.
Ladd.
Marquand.
Mitchell.
Prentiss.

Elementary Logic: MR. PEIRCE. Twice weekly, Monday
Wednesday, 9 A. M., Room C. (5).

Bissing.
Howell.
Robinson, A. J.
Short.
Wilhelm.

Psychology: DR. MARQUAND. Thrice weekly, Tuesday, Thur
and Friday, 12 M., Hopkins Hall Annex. (4).

Brinton.
Howell,
Leftwich.
Robinson, A. J.

Physiography.

DR. CLARKE. Thrice weekly, Monday and Wednesday, 11 A. M., Saturday, 10 A. M., Room G. (15).

Boston.
Canfield.
Cromwell.
Crutchfield.
Duffy.
Earle.
Fels.
Frick.
Glenn, J.
Glenn, W. L.
Jones.
Pund.
Reese, C. L.
Robinson, C. H.
Stratton.

Elocution.

MR. WOODWORTH. Daily, 9 A. M., Hopkins Hall. (16).

Beadenkopf.
Bemis.
Brinton.
Duffy.
Fels.
France.
Gjellum.
Johnson.
Kimball.
Leftwich.
MacClintock.
Mahon, O. L.
Mitchell.
Murray.
O'Connor.
Wilhelm.

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

Published Here.

American Journal of Philology. Edited by PROFESSOR GILDERSLEEVE. *Vol. I. No. II.*

Article I.—Etymological and Grammatical Notes.—By F. D. ALLEN.

The words discussed are: (1) τηλουρός, which is decided to be a compound of ὅρος, οὖρος, in the sense of *watcher*, *looker*, like κηπουρός, and so meaning "watching from afar," "looming up in the distance." (2) θεωρός, from θέα and ὥρα, meaning probably "onlooker at a spectacle." (3) The appearance of the digamma in ἐποίησε in a recently discovered Argive inscription. (4) δαίφρων, which is deduced from δαΐς, "torch," and receives the interpretation "fiery-hearted," "gallant." (5) Siremps, explained as equivalent to *si rem eampse*, "thus in very fact." (6) Macte, which is supposed to be *macte*, an adverb, when joined with *esto*, and *macte*, a vocative, when without *esto*. (7) Temperare, the meaning of which, "restrain," "keep in bounds," is deduced, after Usener, from *tempus*, connected with *templum* in its augural sense, "space marked out." (8) Intrare, penetrare, which are derived from noun-stems *intero*, *penetro*—as *superare* from *supero*.

Article II.—On Recent Investigations of Grimm's Law.—By H. C. G. BRANDT.

The law is restated with the aid of the symbols *x. y. z.* in three formulas. It is claimed that the use of symbols necessitates inquiry into their exact phonetic value, too much neglected when significant letters are used. This is particularly true of x, generally called "aspirate;" y is always the sonant stop, z the surd. For Parentspeech x the value of b' is claimed in accordance with Ellis' observation and Sievers' theory. The groups of languages, which Grimm's Law affects, are best represented by Parentspeech, General Teutonic and High German; not by Sanskrit, Gothic, etc. To the opinion that Sanskrit must show the primitive sounds, was due the first large class of exceptions to the formula Prsp. x > G. T. y > H. G. z. Grassman showed that Sanskrit, Slavic, etc., had shifted to y, and that the formula stands without exception.

The rest of the paper is taken up with Verner's Law, which explains the second class of exceptions, supposed to be such from an undue importance attached to Gothic sounds. The formula in question is: Prsp. z > G. T. x > H. G. y. It seemed to run Skr. z > G. T. y > H. G. z. Verner discovered that the occurrence of both x and y in the second group was due to a difference in the primitive accent. When x stood in the accented syllable it was preserved; if it stood anywhere else, it passed into y already in the G. T. period. Both this y and the one which came from Prsp. x shifted then to H. G. z. Hence there was really no exception to Grimm's Law, but when G. T. x stands in originally unaccented syllables the formula runs: Prsp. z > G. T. x > y > H. G. z as shown by Prsp. patar > G. T. fadhar > fadar > H. G. vater.

Article III.—On the Principles of Orthography of French Verbs ending in -eler and -eter.—By B. F. O'CONNOR.

The writer has collected a complete list of such verbs: and, while admitting that present usage presents inexplicable anomalies, thinks that the main determining factor was etymology: and that the concluding consonant before *e* mute should be doubled in all those verbs which are derived from Latin verbs having *ll* or assimilated *tt* in the infinitive, or from Latin double-diminutives, or feminine nouns: while all others should be written with *è* before the mute *e*.

Article IV.—A Critical Examination of an Edition of Xenophon's Oeconomicus by K. Lincke.—By C. D. MORRIS.

It is shown that the editor has rejected nearly a quarter of the traditional text. The reason which chiefly induced him to make such large excisions appeared to be an impression that the discourse of Socrates with Ischomachus, which occupies the latter p of the book, is to be regarded as the fulfilment by Socrates promise to help his friend Critobulus in his efforts to impro estate. It was shown that no such conclusion is justified b words of the dialogue. The chief objections alleged by L against the passages he expels from the text were then stated it was shown that neither on grounds of consistency and symr nor on those of phraseology and style, is there any adequate r for subjecting the text to such violent and arbitrary mutil Passages were cited from August Boeckh and Leonhard Sp in condemnation of this tendency to ἀθέτησις, which was reg as far too prevalent among scholars of a certain type.

Article V.—On the Fourth Play of the Tetralogy.—By HUMPHREYS.

The writer examines minutely the metrical structure of th clops and the Alcestis, and shows that there was a style of fication which was free from the established licenses of Co while it yet was less rigorous than that appropriated to Tra and which was adapted to what the writer calls a *romance d* He uses the positions thus gained to determine the charac the play to which the recently published fragment of Eur must have belonged. The fragment is quoted at length and conjectures offered and discussed.

SAMUEL GARNER *contributes a note on the so-called "Sub Dubitatif," je ne sache pas.*

The conclusion reached is that *sache* is not here really junctive at all, but that it is phonetically possible as an indic The author believes that there are two inflections of the pr indicative of *Savoir:* one coming directly from the Latin, *je tu saches, &c.;* and a second later one of purely French f tion, *je sais, tu sais, &c.*

The Reviews and Book Notices, contain: Reviews of *Skeat's mological Dictionary*, by A. S. COOK, *and of Mallery's Sign Lan among the North American Indians*, by C. H. TOY. A. M. OTT contributes a *Statement of American Publications in Ro Philology, for 1879.*

Reports are given of the Zeitschrift der Deutschen Mo ländischen Gesellschaft, xxxiii.; Journal Asiatique, April, Germania, xxiv.; Englische Studien, i.; Revue de Philologie 1; Zeitschrift für Romanische Philologie, iii, 4; Rheinis Museum, xxxv.; and Philologus, xxxviii., 3, 4.

Vol. I:, No. III.

Article I.—On Verrius Flaccus, by H. NETTLESHIP.

An account is given of what is known of Verrius Fla (the author of "the first Latin Dictionary ever written"), of what he has suffered at the hands of his epitomator, peius Festus, and of Paulus Diaconus, who in a similar wa down Festus. The bulk of the present article is devoted t attempt to show, with greater exactness than had been don O. Müller, the character of the original work of Verrius Fla and the way in which it is probable that it was made up, an what extent his citations are due to his own researches; but ch to point out that "Verrius arranged his instances under each l in successive series, each of which contained glosses heade citations from the same author." A second article is promise which the attempt will be made to show how we may get at a larger amount of the work of Verrius Flaccus than is containe the epitomes of it, by scrutinizing the quotations in Quintil Pliny, Macrobius, &c.

Article II.—History of ' Coincide' and ' Coincidence.'—By H. E. Shepherd.

The introduction of the words *coincide* and *coincidence* into the English language is traced historically. Quotations are made from various writers, beginning with Roger Bacon, which indicate that the word was first coined by the philosophical writers of the middle age; that it passed from their use into the vocabulary of learned writers of the 17th century and was adopted by the mathematicians to represent the old *congruens*, *congruere;* and that finally its popular use was confirmed by the *coincident* deaths of Adams and Jefferson, on July 4, 1826.

Article III.—The 'Ablaut' of Greek roots which show variation between ε and ο.—By M. Bloomfield.

The paper contains 46 pages, and is divided into five sections. After a brief introduction, in which are stated the most recent opinions of German scholars on the influence of accent, the existence of nasal vowels, and the nature of palatal consonants, with references to the chief works embodying them, the first section points out the inconsistency which is unavoidable if the variations of the roots in question are to be accounted for by an assumed *guna*, and that the facts force us to admit the existence in the earliest times of "a root-system consisting of three forms, two strong ones and one weak one." The second section treats of the important part played by nasal vowels in Greek words. The third section discusses the variation of roots consequent upon the palatalization of original gutturals. The fourth section shows the way in which the original Indo-European accent made itself felt in the forms taken by roots. The fifth section classifies Greek words, verbs and nouns, according as they are regularly made from one or other of the forms of 'ablaut.'

Article IV.—Logical Consistency in views of Language.—By W. D. Whitney.

It is shown that, from the two fundamental facts, that languages are different and that the particular language any man learns is determined for him by the circumstances of his birth, it follows by necessity: (1) That there is no necessary connection between a conception and the word which denotes it: (2) That human language is essentially different from the sounds uttered by the lower animals: (3) That the study of language belongs to the class of historical not physical sciences: (4) That in these facts lies the value of the study of language as an aid to ethnology. Valuable remarks are made also on the historical development of languages, and on what the question as to the origin of language, considered as a scientific one, really implies; and the article concludes with a defence of the classification of language with other social institutions.

The *Reviews and Book Notices* contain an Account, by W. I. Knapp, of the *Catalogue of the Spanish Library*, bequeathed by George Ticknor to the Boston Public Library; a notice, by C. R. Lanman, of various books, recently published, concerning Oriental studies, and among them of *Professor Whitney's Sanscrit Grammar;* an account, by M. Warren, of *Schroeder's and Sonnenschein's* rival publications of the emendations of *Plautus*, found in MS. in Bentley's copies in the British Museum; a review, by Francis Brown, of "*The Origin and Growth of the Psalms*," by by the late Professor T. C. Murray.

Reports are given of Mnemosyne, vii. 3 and 4; Anglia, ii.; Revue de Philologie, iv. 2; Neue Jahrbücher, f. Philol. u. Paed, 1879, parts 9-12; Hermes, 1880, part 1.

American Chemical Journal. Edited by Professor Remsen. *Vol. II. No. 2. June, 1880.*

Article I.—On the Determination of Albuminoids in Hay and Coarse Fodder, by H. P. Armsby.

For the purpose of determining the value of a feeding-stuff it is common to estimate the quantity of the albuminoid nitrogen contained in it. No good method has hitherto been known for distinguishing between non-albuminoid and albuminoid nitrogen. The author describes a satisfactory method in this article.

Article II.—Researches on the Substituted Benzyl Compounds.—Parachlorbenzyl Compounds, by C. L. Jackson and A. W. Field.

This article contains descriptions of the methods of preparation and the properties of a number of new derivatives containing the parachlorbenzyl group.

Article III.—On the Action of Hydrochloric Acid and of Chlorine on Acetobenzoic Anhydride, by W. H. Greene.

It is shown that acetobenzoic anhydride prepared by the action of benzoyl chloride on sodium acetate is identical with the product obtained as a result of the action of acetyl chloride on sodium benzoate. Both substances act in exactly the same way towards hydrochloric acid and chlorine. With the former reagent they yield acetyl chloride, acetic acid, benzoyl chloride and benzoic acid. With chlorine the products are acetyl chloride, chloracetic acid, benzoyl chloride and o-chlorbenzoic acid.

Article IV.—On the relative Densities of permanent Gases at high Temperatures, by J. M. Crafts.

The remarkable results recently obtained by Victor Meyer in experimenting upon chlorine led the author to repeat the experiments in a modified form. Instead of determining the specific gravity of chlorine when liberated from a solid chloride, he determined the specific gravity of the free gas at high temperatures, and finds that it is normal. This indicates a very marked difference in conduct between free and nascent chlorine.

Article V.—The Vapor Density of Iodine, by J. M. Crafts and F. Meier.

V. and C. Meyer in their experiments found that at high temperatures iodine vapor has an abnormal density, being about two-thirds the normal. The authors have found that at a temperature of 1470° the density is only 0.58 of the normal instead of two-thirds. They conclude that the vapor density of iodine compared with air diminishes *progressively* with the increase of temperature between about 600° when it is still normal, and about 1470° when it reaches the value above indicated.

Article VI.—On the Oxidation of Substitution Products of Aromatic Hydrocarbons.—VI. Experiments with Mesitylene, by L. B. Hall and Ira Remsen.

In previous papers it has been shown that whenever an acid group occupies the ortho position with reference to an oxidizable group the latter is protected from the action of certain oxidizing agents. In this paper a case is examined in which one acid group occupies the ortho position with reference to two oxidizable groups in the same compound. It was thought that both the latter groups would be protected, but the experiments thus far performed seem to indicate that this is not true. The experiments are to be continued, however, and it is hoped that the question left open may receive a final answer in the immediate future.

Brief Review of the most important changes in the Industrial Applications of Chemistry within the last few years. (*Continued.*)
Professor Mallet in this report, under the head of "Materials used as Food," speaks of improvements in connection with the chemistry of *Bread*, *Meat*, *Meat Extracts*, *Preserved Vegetables*, *Butter and Cheese*, *Sugar*, *Wine*, *Beer*, *Distilled Spirits*, *Vinegar*, *Artificial Flavoring Essences*, and *Artificial Mineral Waters.*

The remainder of the number is made up of Notes, under which appear: *On the reversal of the direction of rotation caused by ordinary malic acid by a simple change in the concentration*, by G H. Schneider; *The Alkaloids*, by A. Ladenburg; *On the gases retained by occlusion in aluminium and magnesium*, by M Dumas; *The Research Fund in England.*

Vol. II. No. 3. June. 1880.

Article I.—On the Density of the Vapors of some Ammonium Compounds, by W. G. Mixter.

It is shown that ammonium acetates and ammonium benzoate dissociate completely into ammonia and the respective acids when heated under low pressures. $2NH_3SiF_4$, NH_3BF_3, and $2NH_3SnCl_4$, dissociate at temperatures above 300° into ammonia and the respective compounds of fluorine and chlorine.

Article II.—Researches on the Substituted Benzyl Compounds: Parachlorbenzyl Compounds, by C. L. Jackson and J. Fleming White.

This paper is a continuation of the one of the same title in the foregoing number of the Journal.

Article III.—Preliminary Note on the Synthesis of Methylconine and Constitution of Conine, by Arthur Michael and Charles Gundelach.

A base isomeric with conine was obtained by heating normal butylidene chloride (CH_3—CH_2—CH_2—$CHCL_2$) with alcoholic ammonia. By the action of an alcoholic solution of methylamine on normal butylidene chloride a base was obtained which appears to be identical with natural methylconine.

Article IV.—1. On a new Variety of Tetrahedrite, by F. W. Clarke and Mary E. Owens. *2. Specific Gravity Determinations*, by F. W. Clarke.

Article V.—Concerning Iodine, by Victor Meyer.

The author states that by a modification of the method of heating originally employed by him he has succeeded in reaching a materially higher temperature, and that the vapor density of iodine at this point agrees very closely with the value calculated for I.

Article VI.—On the Determination of Barium as Chromate, by H. N. Morse.

Frerichs states that the presence of acetic acid is a necessary condition to the complete precipitation of barium as chromate. This statement the author finds to be correct, but the further statement that barium chromate may be washed with dilute acetic acid was found to be incorrect. It was shown that barium chromate cannot be washed with even the dilutest solutions of acetic acid without loss. A further result established by the experiments undertaken by the author is that, if a small quantity of chromate of potasium is added barium chromate may be washed with quite concentrated solutions of acetic acid without passing into solution.

Article VII.—On A-Toluenedisulphonic Acid and its Derivatives, by C. Fahlberg.

Toluenedisulphonic acid is prepared, on the one hand, by treating paratoluenesulphonic chloride with sulphuric acid, and, on the other hand, by treating orthotoluenesulphonic acid with sulphuric acid. This shows that it contains one sulpho-group in the para and one in the ortho-position with reference to methyl. By oxidation of the amide of the acid with potassium permanganate a substance belonging to the class of sulphinides, viz: $C_6H_3\left\{\begin{array}{l}CO{-}_{1}\\SO_2NH\\SO_2NH_2\end{array}\right.$ was obtained together with the dipotassium salt of disulphobenzoic acid, $C_6H_3\left\{\begin{array}{l}COOH\\SO_2OK\\SO_2OK\end{array}\right. + H_2O$. From both of these products, by fusion with potassium hydroxide, dioxybenzoic acid was obtained, and from this, by simply heating, resorin.

Report on the Progress of Analytical Chemistry, by H. N. Morse.

Report on Progress in Physiological Chemistry, by R. H. Chittenden.

Reviews of Post's "*Grundriss der chemischen Technologie*," and of Girardin's "*Lécons de Chimie élémentaire appliqué aux Arts Industriels*, by J. W. M.

The number is closed by a list of *Recent Publications relating to Chemistry*.

Vol. II. No. 4. October, 1880.

Article I.—Researches on the Complex Inorganic Acids, by W cott Gibbs.

This paper is a continuation from p. 217, vol. I. It conta the results of a series of laborious examinations of the complica *phospho-tungstates*. Details in regard to the methods of prepa tion, the properties and analytical methods employed are giv In this installment of the memoir there are described especi members of the twenty-four-atom series and of the twenty-t atom series. The fundamental acid of the former series is WO_3, P_2O_5, $6\ H_2O$, + 47 aq., that of the latter series 22 W P_2O_5, $6\ H_2O$ + 45 aq.

Article II.—On the Detection and Determination of Arseni Organic Matter, by R. H. Chittenden and H. H. Donaldso

In the process described, which is a modification of that f employed by Gautier, the features of special advantage are: treme accuracy, great delicacy, and the use of but three chemic nitric acid, sulphuric acid, and zinc. A simple form of the Ma apparatus is recommended which, it is claimed, appears to comb all the essentials of a perfect apparatus. The presence of orga matter, according to prevalent opinion, interferes with the test arsenic by Marsh's method. The authors show that this is truc. A number of quantitative experiments were made to det mine the delicacy and the accuracy of the new method and th gave very satisfactory results.

Article III.—Estimation of Sulphur in illuminating Gas by bu ing in Oxygen, by W. G. Mixter.

A quantity of the gas measured by a dry meter is burned in large glass vessel, which is kept cool during the operation. T products of combustion are afterwards treated with bromine a then washed out into an appropriate vessel, evaporated to a sm volume, and the sulphuric acid determined as barium sulphate.

Article IV.—A Synthesis of Water for a Lecture Experiment, W. G. Mixter.

Article V.— Tubulated Crucible for use in estimating vola Products of Ignition, by F A. Gooch.

This paper needs the accompanying drawing to make it cle and is not suitable for extraction.

Article VI.—Researches on the Substituted Benzyl Compounds: On Paraiodbenzyl Compounds, by C. L. Jackson and C. F. Mabe

The compounds described in this paper are similar to those d scribed in the two preceding numbers, differing from them in co taining iodine in the benzene-nucleus instead of chlorine. T properties and methods of preparation of a number of these co pounds are given in detail.

Article VII.—Chloro-nitro-phenetol, by Edward J. Hallock.

Chloro-nitro-phenetol is best prepared by treating phenetol fi with a mixture of potassium chlorate and hydrochloric acid, a the chlorophenetol thus obtained with concentrated nitric acid.

Brief Review of the most important changes in the Industri Applications of Chemistry within the last few years—(Continu by J. W. Mallet.

The subjects taken up in this report come under the gene heading—

"Materials and Processes connected with Clothing." The s headings are: *General Chemical Treatment of Textile Materials Bleaching, including Manufacture of Chloride of Lime; Preparati of Dye Stuffs; Artificial Coloring Matters; Mordants; Dyeing Calico-Printing; Tanning; India Rubber; Gutta-percha, etc.*

Report on Progress in Physiological Chemistry, by R. H. Chi tenden.—

The Subsection of Chemistry at Boston.

A letter giving a brief account of the proceedings of the Subse tion of Chemistry of the American Association for the Advanceme of Science at the meeting held at Boston, in August, 1880. F. W. Clarke.

Ozone in the Air, by E. Schöne.

No. 5. November, 1880.

'e I.—Researches on the Complex Inorganic Acids, by WOL-
'IBBS.

'wenty-atom series of phospho-tungstates is first considered,
nple of which is the normal barium salt.

$$20\ WO_3\ P_2\ O_5.\quad 6\ BaO + 48\ aq.$$

he *eighteen-atom series* the potassium salt $18\ WO_3\ P_2\ O_5.$
$+ 23$ aq., is a good example. Then follow detailed
s of representatives of the *sixteen-atom series* and the *four-*
n series.

ırsenio-tungstates, as far as examined, correspond in a gen-
y to the phospho-tungstates, though they appear to be, as
ess well-defined than these last.

general results of the investigation of the phospho-tungs-
y be stated briefly thus:

ıe phospho-tungstates form a series of which the lowest
obably contains six atoms of tungstic to one of phosphoric
ınd the highest, twenty-four atoms of tungstic to one of
oric oxide.

: least the greater number of phospho-tungstates contains
ı number of atoms of tungstic oxide. The homologizing
r these cases is therefore $2\ WO_3.$

he highest number of atoms of base observed in any case
ld style), which implies that the acid contains twelve atoms
oxyle.

ı all cases observed the number of atoms of hydroxyl re-
by a monatomic metal is even.

ne instance occurs in which two acid phospho-tungstates of
t orders appear to unite to form a definite compound; but
e admits of a different explanation.

ı all phospho-tungstates studied the number of atoms of
· of hydroxyl is more than sufficient to saturate the phos-
oxide present, if we admit that the acid is 12-basic. At
part of the hydroxyl or base must therefore be united to
: oxide.

le II.—Estimation of Alkaloids by Potassium Mercuric Iodide,
ERT B. PRESCOTT.

362 F. F. Mayer introduced into use a standard solution of
ic iodide with excess of potassium iodide, in a method for
ımetric determination of the chief natural alkaloids. The
. was not, however, found to give uniformly satisfactory re-
ıd the author has, from time to time, with the aid of students
Jniversity of Michigan, endeavored to render it more precise
stigating the nature of the precipitates formed with different
ls, and determining the best conditions for effecting the
ation.

'le III.—On the Ethers of Uric Acid:—Dimethyluric Acid,
B. HILL and C. F. MABERY.

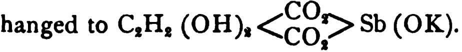
ethyluric acid was made by heating diplumbic urate with
iodide. It is a crystallized substance. It yields salts, sev-
which are prepared and examined. By treatment with
hloric acid it breaks up according to this equation:
$CH_3)_2\ N_4O_3 + 5\ H_2O = 3\ CO_2 + NH_3 + 2\ CH_3NH_2 +$
$NO_2.$
ol.
lized with nitric acid it yields methylalloxan and methylurea.

ıne inference from their experiments, the authors say: "It
n shown that the two hydrogen atoms of uric acid which are
d in the formation of salts are directly connected with two
ıt nitrogen atoms; furthermore, when methyl groups are
ced in the place of these hydrogen atoms, that two other
en atoms may then be replaced by metals. The only
explanation of this behavior would seem to be that the
ydrogen atoms of uric acid are attached to four different
n atoms, and that only two of these hydrogen atoms can
aced at the same time by strongly basic radicals."

Article IV.—Researches on the Substituted Benzyl Compounds:—Orthobrombenzyl Compounds, by C. L. JACKSON and J. FLEMING WHITE.

The compounds described in this paper are orthobrombenzyl alcohol, $C_6H_4\ BrCH_2OH$; orthobrombenzyl cyanide; orthobromparatoluic acid, $C_6H_4\ BrCO_2H$ and its salts; the sulphocyanate; and orthobrombenzylamines.

Article V.—The Constitution of the Tartrates of Antimony, by F. W. CLARKE and HELENA STALLO.

It is shown that the free acid corresponding to tartar-emetic undergoes decomposition very easily and yields orthoantimonious acid $Sb\ (OH)_3.$ From this fact the authors are inclined to think that the commonly accepted formula for tartar-emetic might better be changed to  $C_2H_2\ (OH)_2 {<}\begin{smallmatrix}CO_2\\CO_2\end{smallmatrix}{>} Sb\ (OK)$. This formula does away with the necessity of assuming the presence of the antimonyl group SbO in the salt.

Article VI.—On the Relative Stability of Certain Organic Salts, by MILES BEAMER and F. W. CLARKE.

The barium salts of methyl, ethyl, propyl, isopropyl, isobutyl and amylsulphuric acids were subjected to the same gradual increase in temperature and the extent and rate of decomposition of each noted. From the experimental data the conclusion is drawn that with the compounds of higher molecular weight, decomposition begins more slowly, but proceeds farther, than with the lower salts of the series.

Article VII.—Some New Salts of Uranium, by F. W. CLARKE and MARY E. OWENS.

Article VIII.—Graphite from Ducktown Tennessee, by W. L. DUDLEY and F. W. CLARKE.

Article IX.—On the Distribution af Arsenic in the Human Body in a Case of Arsenical Poisoning, by S. W. JOHNSON and R. H. CHITTENDEN.

A recent case of arsenical poisoning, in the State of Connecticut, led the proper authorities to demand a chemical examination of the body of the victim. Accordingly a large number of analyses of different parts of the body were made, and some facts of scientific interest with reference to the distribution of the arsenic were established. The arsenic was found in all the tissues and organs examined, though only an unweighable trace was detected in the brain.

Article X.—Synthesis of Salicylic Acid, by EDGAR F. SMITH.

When 1 part of copper benzoate is heated with about 3 parts of distilled water in a sealed tube at 180°, for three hours, a reaction takes place, which may be represented by the following equations:

$$2\ [(C_6H_5CO_2)_2\ Cu] + 2\ H_2O = Cu_2O + 3\ C_6H_5CO_2H + C_6H_4OH\ CO_2H.$$

Salicylic acid.

The yield of salicylic acid was not very abundant.

Recent Progress in Agricultural Science, by H. P. ARMSBY.

This is the first installment of a report on progress in the chemistry of agriculture. The chief subjects here taken up are the "*Effect of Temperature on the Vitality and Germination of Seeds*," and the effect of the "*Presence of Oxygen.*"

Following this report there are Reviews. 1st of *Lunge's Treatise on the Manufacture of Sulphuric Acid and Alkali*, by J. W. Mallet; 2d. of *Beilstein's Handbuch der organischen Chemie;* 3d. of *Wurtz's Atomic Theory;* and 4th. of *Some Recent Investigations in Physical Chemistry*, particularly Julius Thomsen's *Thermochemical Investigations of the Theory of Carbon Compounds*, and J. W. Brühl's *Investigations on the Relations between the Refractive Powers of Bodies and their Chemical Constitution.* The last three reviews are by the editor.

The number closes with notes on: *The Opium Alkaloids*, by E. v. Gerichten; *River Water*, by C. M. Tidy and E. Frankland; *Two Remarkable Cases of Metamerism*, by L. Schreiner; *The Atomic Weight of Glucinum*, by Lothar Meyer; *The Nature of Caucasian Petroleum*, by F. Beilstein and A. Kurbatow.

PROCEEDINGS OF UNIVERSITY SOCIETIES.

Abstract of the More Important Papers Read at Recent Meetings.

Scientific Association.

A review of a recent paper by Julius Thomsen, of Copenhagen, entitled: " Thermochemical Investigations on the Theory of Carbon Compounds, by IRA REMSEN.

In the paper it is shown that, by simple mathematical processes, starting from the figures representing the heat of combustion of some of the simpler hydrocarbons and the two oxides of carbon, a general formula can be deduced for the heat of formation of any hydrocarbon. By an application of this formula the structure of certain hydrocarbons can be determined, if the heat of combustion is known. As the determination of the heat of combustion is easily within the range of experimental possibilities, we have thus a new method, independent of the usual chemical transformations, for determining the structure of compounds. In the review sufficient of the details of the original paper were given to furnish an idea of the methods of reasoning and calculation adopted by Thomsen. A detailed review of the same paper is given in the "American Chemical Journal," vol. II., No. 5. (November, 1880.)

The Development of Phoronis: A Contribution to the Study of Animal Metamorphosis, by E. B. WILSON.

This communication gave an account of a paper by the author, read before the American Association for the Advancement of Science, at Boston, an abstract of which will appear in the "American Naturalist." An attempt was made to explain the steps by which the remarkable metamorphosis of *Phoronis* may have arisen.

Starting from a common point, the larva and adult have developed in two very different directions, by becoming adapted to entirely different conditions of life. The peculiar metamorphosis enables the creature to pass directly from one condition to the other, without losing time and energy in a stage of transition.

The peculiar disposition of the alimentary canal in *Phoronis* may be explained as the result of the flexure of a primitive form, whereby the anus was brought beside the mouth. The external flexure disappearing by fusion of the two parts thus brought into proximity, the animal attained its present structure.

Researches in Hydrodynamics, by H. A. ROWLAND.

The paper gave some of the results of an original investigation in Hydrodynamics, the fuller statement of which is about to appear in the American Journal of Mathematics.

On the Rotation of the Plane of Polarisation of Light by Reflection from the Surface of Strongly Magnetized Nickel, by E. H. HALL.

Three specimens of this metal have been experimented upon, all producing a decided effect of the same sign as that observed with iron.

On the Rate of Increase of the Speed of Trotting Horses as deduced from Statistics by the Graphical Method, by C. S. HASTINGS.

Philological Association.

Recent attempts to explain the forms attributed to the verb which appears in our Lexicons as φρέω, by C. D. MORRIS.

To Nauck's hypothesis of a verb arising by contraction from πρό ἵημι. Brugman objects (1) that no primitive *verb* can be cited as treated in this way, which is the more necessary, considering the laxity of the connection of prepositions in general with verbs, and (2) that Nauck is forced to reject or alter in an arbitrary way several of the forms which have to be accounted for. Curtius assumes that the root is *φρη*—from *bher*, *φερ*—(as βλητός is related to βέλος, etc). Brugman shows that though several of the forms in question may be accounted for by this assumption, still some of Curtius' analogies will not bear a close scrutiny, and that consequently his theory fails to account for several of the traditional forms. Brugman's own view is that Curtius' root *bher*, *φρη*—may be accepted as most easily explaining most of the forms; and that as there was a strong resemblance between some of these forms and those of ἵημι, as well as a close similarity in meaning, the two verbs became associated in the popular mind; and that thus the forms which are not referable to *φρη*—were made on the pattern of forms of ἵημι, though there is no etymological connection between the two verbs.

A note on Sievers' 'surd media' and Paul's 'sonant tenuis,' by H. C. G. BRANDT.

It was claimed that such sounds do not and cannot really exist. They re due first to an inaccurate use of terms, and secondly to the failure of th or High Germans to appreciate the surdness and sonancy of certain consonants. Substitute for 'media' and 'tenuis,' 'fortis' and 'lenis' proper terms 'sonant' and 'surd stops' and the impossibility and absu of 'surd' sonant stops and 'sonant' surd stops are apparent.

The surdness of all South German stops must be maintained.

It is only the result of the general High German tendency to turn e sonant into the surd stop. This tendency appears in the pronunciatio b, d, g in *lieb*, *bad*, *ging*; in Grimm's Law, Formula I.—Parent-Speech General Teutonic y > High German, z and in Formula III with Ver Law P. S. z > G. T. x > H. G. y > H. G. z. The South Germans al pronounce b, d, g initially as all Germans pronounce them finally i. e., t turn them into surd stops.

On some Inaccuracies in Du Cange's Glossarium mediae et inf Latinitatis, by A. S. COOK.

The words of Anglo-Saxon origin in Du Cange were subjected to exa nation, and it was shown: (*a*) That the spelling of words in the Inde pended to the last volume is often no guide to their actual forms in Glossary proper. (*b*) That a large number of words defined and illustr in the Glossary, many of them of peculiar importance, have never b entered in the Index. (*c*) That, of the words actually defined, the dis tions in spelling are numerous. (*d*) That in certain cases passages do exist in the places to which reference is made, while in others no proof ci tations are furnished. (*e*) That wrong etymons are frequent, though m of them should have been eliminated by the reviser. (*f*) That an obli case, often the dative, of an Anglo-Saxon noun, is entered and treated a nominative.

The Negative Particle Mie in Villehardouin and La Chans Roland, by B. F. O'CONNOR.

Mie is employed about forty times in the Chanson de Roland (XI C tury), and nearly one hundred and thirty times in the Conquête de Cons tinople (XIII Century). Its grammatical construction is also sli different and shows that in the XI Century the original significatio *mie* (viz., a very small particle) was generally respected, whereas in t XIII Century it had almost entirely disappeared.

On certain important differences between Sixteenth and Ninete Century French, by A. M. ELLIOTT.

The general tendency of XVI Century French is to elliptical co and the omission of subject personal pronouns in subordinate or in t second of coordinate propositions, The principle of phrase-shortening is il lustrated by the use of interrogative pronouns in indirect narration: dire subjunctive constructions without *que* are the rule. Time is saved by cert striking infinitive constructions after *verba dicendi et sentiendi* (*Il estimait* etc.). A singular species of attraction is seen in the abnormal phrase, *ce s les Américains*=*C'est les Américains*, of XVI Century. Grammatical cons tions differed from ours, but had their *raison d'être* in the traditions of t old language. Illustrations from folk-speech—*j'ai tombé mon cha* Mobility of syntax-elements is a chief characteristic.

A New Interpretation of ἀσπλαγχνος *in Sophocles, Ajax*, 472, b C. D. MORRIS.

The interpretation of Soph. Aj. 472 was discussed; and it was shown t the common rendering of ἀσπλαγχνος as cowardly could not be justified i the analogy of ἀκηριος because there was no evidence (with one possible e ception) that the simple word σπλάγχνον (σπλάγχνα) was ever employed the sense of *courage* or for the seat of *combative* emotions. From the us the word in post-classical times it would rather seem that the tendency of t Greek mind was to associate it with the feelings of tenderness and sympat It was suggested, therefore, that the meaning of ἀσπλαγχνος in this line rather to be derived from the sense the simple word bears in Soph. Ant. 10 (τῶν σῶν ἐκ σπλάγχνων ἕνα). The wish of Ajax will then be that he may able to prove to his father that he is in very truth his son. It was mentio also that this meaning is now given to the word by Wecklein, who transla it, *degener illius natus*.

On the Guttural Nasal as Consonant and Vowel and its Rep resentation in Sanscrit and Greek, by LOUIS BEVIER, JR.

In most alphabets the guttural nasal, even as a consonant, has no app priate sign, and as a vowel is always represented by a digraph. Its existe as a vowel in Greek and Sanscrit rests on exactly the same proofs as the the dental and labial nasal vowels. The guttural nasal is a true Indo-Eu pean semi-consonant, and fails to show the fluctuation between vocal a consonantal condition only because it does not stand at the end of any Ind European root. The tables of semi-consonants given in Mr. Bloomfield article on "The Greek Ablaut," in the last number of the American Jou of Philology should be completed by this addition.

Historical and Political Science Association.

The Irish Land Question, by H. C. ADAMS.

It was the object of this paper to present the Irish Land Question as it appears at the present day. For that purpose the form of land tenure previous to the Gladstone Land Act of 1870 was considered, as well as the economic conditions which that form of tenure had entailed upon Ireland. The conditions of the Act itself, its workings during the past ten years, and the prospect which it has secured for Ireland were also considered. A study of the question leads to the conclusion that the Gladstone Land Act, while correct in principle, is defective because it is incomplete. It is but the first step in a reform which Ireland needs.

A Review of a Recent Work by Henry Mann on "Ancient and Mediæval Republics," by M. I. SWIFT.

Mr. Mann was criticised for having attempted no comparisons.

Adopting the comparative method, it was shown that the Italians had developed with much less freedom than the Greeks; but were, like them, a new people. The working out of popular freedom was the great characteristic of both. In this, each Greek and Italian city passed through the same phases. The Persian War may be compared with that waged by Frederic Barbarossa; and the War of the Peloponnesus with the later struggles between Guelph and Ghibelline. The intense political life in both countries was the main cause of their great intellectual activity. The small size of each republic, the limited citizenship, commercial activity and the turbulent spirit of the people were causes of this intense life; limited citizenship and the system of mercenary soldiery hastened the downfall of the Republics.

The Greeks differed from the Italians in their greater regard for precedent. They also colonized, and cultivated oratory. Religion had opposite effects upon each. Individual cities were alike; Florence resembled Athens, and Venice, Sparta. Finally, Italian commonwealths did for the modern world what Greece had done for the ancient. They gave new birth to thought and freedom.

On the Social Tendency of Public Debts, by H. C. ADAMS.

A consideration of this subject falls under two heads: First, that of foreign debts or indebtedness from the one government to the citizens of another government; second, domestic debts or indebtedness from a government to its own citizens. In the first case public debts have a tendency to render the citizens of the debtor nation dependent upon the will of the citizens of the creditor nation, since, according to the practice of International Law, the proceeds of taxes must first go to satisfy the foreign obligations. This may be defended or deprecated according to the condition of the countries.

In the second case public debts do not have any tendency to produce class dependence, but to render permanent whatever class relations already exist. A centralization of capital is necessary before public debts can be contracted, but this is the result of the rules of distribution adopted by the country, and not of the employment of the borrowing system. Their social tendency is of but slight importance in the study of public debts.

The Pilgrim Fathers as Colonists, by H. B. ADAMS.

Without denying that religious liberty, in church form, was a prime consideration with the Pilgrims, it was attempted to show that secular motives entered largely into the determination to emigrate from Holland, where the Pilgrims already enjoyed perfect toleration. "The hardness of the place and country they were living in" (to use one of their own phrases); the desire to find a land where they could not only have liberty, but "live comfortably," the longing to "keep their names and nation," to retain the language and legal status of Englishmen, to enjoy the sovereign "protection" of England, whose grudging patronage they preferred to Dutch offers of free transportation and colonial outfit; the ambition "to enlarge the domains" of the English State, as well as of the Church of Christ, the intention to found a civil commonwealth (as their "intended course of civil community," spoken of by John Robinson, clearly proves); in short, the aim, common to all colonists since the world began, of bettering their actual condition, had no inconsiderable influence with the Pilgrim Fathers.

The reverence of the Plymouth colony for English law and civil government was also discussed. It was shown that the Pilgrims' compact was based upon English ideas of contract and civil polity; that Plymouth "courts of justice and magistrates" were "essentially civil;" that jury trial "according to the precedents of England," was one of the first acts of Plymouth legislation; that Plymouth lawgivers followed English precedents in the matter of legal penalties, laws of inheritance, conveyancing, land tenure, taxation, church rates, parish institutions, and local self-government in Church and State, and that church membership was not necessary for suffrage, as the case of Miles Standish proves.

English and Colonial Witchcraft Laws, by E. M. HARTWELL.

The aim of this paper was to show the operation of English law and thought in the witch trials of certain American colonies, as well as in the more familiar case of Salem. The course of English legislation respecting witchcraft was treated from the time of Cnut to that of James I. During the seventeenth century there was a wide-spread and genuine belief in witchcraft amongst all classes from the sovereign to the rabble. The witchcraft act of James I., which remained on the statute books from 1604 to 1736, was enforced or held to be in force in Nova Scotia, Massachusetts, Connecticut, Rhode Island, New York, Pennsylvania, Maryland, Virginia, and South Carolina.

Recent Changes in Japan, by KAKICHI MITSUKURI.

The object of this paper was to show the causes, extent, and significance of the vast changes, both political and social, which have occurred in Japan. The constitution of the government and the state of society, forty years ago, were briefly described. The Emperor or Mikado was then, and had been for eight hundred years, the nominal head of Japan, but the actual power was in the hands of the Tokugawas, who was only a vassal and had usurped the control of the country. Below the Tokugawas was a class of feudal lords, known as Daimios, some of whom were rich and powerful. Both the Tokugawas and the Daimios depended for their strength upon the Samurai, or soldier-class, the most intelligent body of men in the country and distinguished for their virtues, traditions, and code of honor. Below the Samurai was the great maſs of people. The tranquil state of society, the universal contentment engendered by a long peace of two hundred and fifty years, was disturbed by two revolutionary elements: (1) the study of history, which developed loyalism to the Mikado, who had been unjustly deprived of his rights; (2) the ambition of certain Daimios, originally the equals of the Tokugawas, to overthrow the usurper.

The occasion of the revolution was the advent of foreign nations, demanding treaties of peace and commerce. The Mikado refused the Tokugawas permission to open the country, and yet outside pressure was so strong that the latter ruler was forced to conclude treaties with America, England, France, Holland, and Russia. This was the signal for revolution, and for the restoration of the Mikado, which was finally effected in 1868. This restoration made all subsequent reforms possible. The spirit of change which has swept over the country was illustrated by incidents in the writer's own experience.

The two main questions now before Japan are (1) the creation of a national assembly, (2) the revision of treaties with foreign powers. The unsatisfactory condition of the foreign relations of Japan was discussed at length. The insults and abuses which Japan has had to suffer at the hands of the western powers, especially of England, are keenly felt by every Japanese. Western countries do not realize how unjustly and brutally their representatives in Japan are behaving. For example, foreign ministers, with the exception of the American, insist that the quarantine regulations, made by Japan, interfere with the trade of their nations, and therefore must not be enforced. In 1879 the German minister, at the instigation of the minister of England, sent a gunboat to take out a German merchantman, which had come from a port with a cholera epidemic, from the quarantine station, near Yokohama, and landed the passengers and goods under the protection of the guns from the war-vessel.

The Coat of Arms of Maryland, by W. H. BROWNE.

After adverting to the fact that during the recent celebration about nine wrong coats were displayed to every right, which seemed to indicate a general want of information upon the subject, and exhibiting a copy of the correct coat, as described in the letter of Cæcilius Calvert, (quoted in Bozman's History of Maryland), he explained the historical, political, and heraldic significance of the device, and showed why it was that, while other colonies marked their assumption of independence and emphasized their breach with the past by the adoption of new symbols, Marylanders had neither desire nor reason to abandon a cognizance that had always been to them the emblem of the rights and liberties which they took up arms to defend.

On Newspapers as Sources of History, by H. B. ADAMS.

The extent and value of the files of Baltimore newspapers preserved in the library of the Maryland Historical Society were represented, and measures were urged for the preservation of files of contemporary newspapers from the Mercantile Library. A full list of these is in preparation for publication.

On Machiavelli, by EDGAR GOODMAN.

On Systems of Rent from the Comparative Standpoint, but with particular reference to the Baltimore System of Ground Rents, by T. J. LEFTWICH.

A Review of a Work on Progress and Poverty, by Henry George (San Francisco, 1879), by H. C. ADAMS.

Note on the History of Geography, by E. M. HARTWELL.

On the Status of the Negro in the South, by W. J. THOMAS.

On Karl Marx and the International, by D. L. BRINTON.

A Review of Short's North Americans of Antiquity, by E. W. BEMIS.

The Disturbances in Barbadoes in 1876, by J. F. JAMESON.

Metaphysical Club.

The Logic of the Epicureans, by ALLAN MARQUAND.

This paper considered (1) the logic of Epicurus and (2) its development by Zeno, of Sidon, 200 years later.

(1.) In treating the views of Epicurus notice was taken of his teaching that words are signs of things (not of our ideas of things), that knowledge springs from sensation, that sensation and feeling are tests of truth. It was pointed out that he laid the basis for a philosophy of discovery by asserting as a fundamental principle that phenomena are signs of the unknown, and by his having distinguished two modes of investigation (the μοναχός and the πλεοναχὸς τρόπος). Contrast this with the rhetorical analysis of the Stoics.

(2.) Zeno, of Sidon, starting from the foundations of Epicurus, constructed a logic which paid special attention to the problem of induction. The method of resemblance which he describes is better than mere induction *per enumerationem simplicem*. It implies the observation of "varied" as well as "many" instances of a phenomenon. In the hands of Zeno, Epicurean logic becomes emancipated from its bondage to Physics. Logical principles and methods are investigated, and logical rules receive a formal statement. The logic, moreover, has grown less dogmatic, and thus stands in close relation to Skepticism.

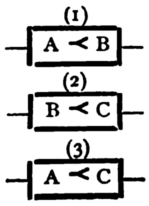
On Purpose in Thought, by JOSIAH ROYCE.

There are three possible ways of studying human thought. The first is the way of psychological analysis; the second of logical analysis. A third is that of the analysis of thought considered as an activity having some definite purpose. This may be called the teleological analysis of thought, and this method of thought-study formed the special subject of the essay.

Asking, then, "what is the purpose of purely theoretical thought?" the essayist first considered the attempted answer, that "the end of thought is correspondence with a reality external to thought" This answer was found inadequate, since thought can only grasp its own content. The next answer, that "the end of thought is the attainment of a confidence that it is in agreement with a reality external to itself," was found not to cover the case, in which thought aims to apply to experience certain axioms that only make assertions as to regularities of sequence in experience, not as to anything existing external to experience. As a better answer, the essayist then began the examination of the following statement of the ends of thought: "Thought purposes to get the mastery over experience, so as to be able to predict future experience, and to know in general the laws of sequence in experience." As a particular case of the purpose of thought thus defined, the essayist took that of the axiom of uniformity. The effort to find in the axiom of uniformity an expression of the unity and necessary continuity of self-consciousness was first examined. This view was rejected as insufficient, because it does not show why or how we conceive of experience as following exact and fixed law, not as merely containing some indefinite sort of general uniformity. Next in order came the theory lately stated in full by Mr. Shadworth Hodgson, the theory that reduces the axiom of uniformity to a mere consequence of the axiom of identity. This doctrine was set aside as not adequate to the real claims of the axiom of uniformity. There remained apparently only the skeptical conclusion that the purpose of thought cannot be adequately expressed without exceeding the limits set by the data of consciousness. In short, as thought aims at anticipating experience, and yet does not create experience, there would seem to be an eternal conflict between the end and the means of realizing it. Experience as past and as future really is in one sense the construction of thought itself, which, dealing always solely with the present, constructs for itself the conception of past and future by its own activity, and hence is able to make certain formal assertions about the nature of these, its own constructions. From this point of view past and future experience appear as projections outward of certain data of present consciousness, so that these data appear to have a validity beyond the present moment in which they are immediately given. The axiom of uniformity expresses a necessary part of the conception of experience as a whole formed in and by this conception, and so has a necessary validity. These considerations led to the final statement of one great purpose of thought. "The end of thought in assuming the axiom of uniformity is the construction of an ideal picture of a world of experience that shall be seen as one."

An Account of a Machine, which he had Invented, for Producing Syllogistic Variations, by ALLAN MARQUAND.

The machine presents to view three flaps containing the two premises and conclusion of a syllogism, as in the diagram.



Each flap on making a half revolution presents a contraposed form of the proposition. By a simple mechanism of friction wheels flap No. (1) makes its half-revolution at the end of every turn of the crank. Flap No. (2) makes its half-revolution at the end of every alternate turn. Flap No. (3) at the end of every fourth turn.

Thus from Barbara, contraposing by negation, we have the following variations.

$$\begin{array}{ccccccc}
\bar{B} \prec \bar{A} & A \prec B & \bar{B} \prec \bar{A} & A \prec B & \bar{B} \prec \bar{A} & A \prec B & \bar{B} \prec \bar{A} \\
B \prec C & \bar{C} \prec \bar{B} & \bar{B} \prec \bar{C} & B \prec C & B \prec C & \bar{C} \prec \bar{B} & \bar{B} \prec \bar{C} \\
\therefore A \prec C & \therefore A \prec C & \therefore A \prec C & \therefore \bar{C} \prec \bar{A} & \therefore \bar{C} \prec \bar{A} & \therefore \bar{C} \prec \bar{A} & \therefore \bar{C} \prec \bar{A}
\end{array}$$

By various modifications of Barbara and by adopting other modes of contraposition an indefinite number of similar variations may be secured.

On a Method of Arriving at, and a New Notation for, DeMorgan's Twenty Propositions, by O. H. MITCHELL.

Let. A = all of A, a = part of A, $\bar{A}$ = all of *non*-A, and $\bar{a}$ = part of non-A. Qualifying a second term, B, in the same way, and affirming and denying the identity of each modification of the first term with each of the second, we get thirty-two propositions, of which, however, twelve are mere repetitions. The twenty distinct ones are the same as De Morgan's Twenty Propositions. Those in which both terms are small letters are his Eight Simple Propositions.

If we write these eight propositions with negative unity affixed as an exponent in the place of each dash, all syllogism, excluding combinations of particulars, becomes mere algebraic multiplications of premises, with the convention that the conclusion is zero unless the middle term disappears from the product. Thus, $(a^{-1}m)^{-1} \times b^{-1}m = a\,b^{-1}$, but $(a^{-1}m)^{-1} \times b\,m^{-1} = 0$, &c.

Richard Wagner's Theory of Music as an Art, read for the author by W. S. Pratt.

Wagner's musical philosophy rests upon the doctrine of philosophy that in general the external, phenomenal world is known to us only in terms of the internal, real world of consciousness, and that the two are thereby recognized to have the same essential nature. The aim of Art is to represent this inner essence. Since, then, mind and matter must be conceived as existing in time and space respectively; since music accomplishes its representative task through the immaterial medium of time alone, and since audition (as compared with vision) tends to obliterate the distinction between the Ego and non-Ego, music is the greatest and most deeply expressive of the Fine Arts. In practice, however, she should satisfy intellectual cravings by associating together all the arts into a unified drama, having for its subject the Myth as giving the truest picture of humanity. This is the "Kunstwerk der Zukunft," and is curiously analogous to the unificatory tendencies in contemporary science.

In conclusion, the unquestionable success of Wagner was described in realizing his theories in "The Nibelungen Trilogy," and more especially in "Tristan and Isolde."

A Report on Wundt's Logik (Bd. I. Erkenntnisslehre), by G. S. MORRIS.

Attention was called to those passages (among others) in which the author, eminent as a physiological and psycho-physical investigator, reinforces the old position, that no conscious mental act is finally accomplished through merely psycho-physical processes in general, or through processes of association in particular. In addition to these there must be an "apperceptive synthesis," or act of intellectual recognition, which is essentially volitional, and proceeds from the "thinking self,"—the latter being directly and fully known in self-consciousness as the veritable noumenon or "thing-in-itself," and not simply as an impenetrable phenomenon. Psychological laws are, therefore, not logical laws. Psychology is a natural science, logic (along with ethics and aesthetics) a mental science. The analogy for a final interpretation of all existence is to be sought in mind rather than in "nature."

A Problem in Mental Physiology, by W. T. SEDGWICK.

An opinion, held by eminent physicians, leads to the conclusion that emotions, or emotional methods of thought, are much more exacting of cerebral tissue than any other functions of the brain.

The author of this paper believes that this is chiefly owing to two things. First, because the process involved is much more complex than usual, and second, because very many emotions have no reflex ancestry; while, being the offspring of civilized life, inheritance and long use have not yet reduced them to a condition so reflex that they may be produced economically.

An Account of Francis Galton's Psychological Inquiries, by ALLAN MARQUAND.

These embraced (1) Psychometric Experiments with associated ideas, an introspective mode of research to ascertain the properties of such ideas and the time required for their production: (2) Statistics of Mental Imagery, involving a comparison of introspective inquiries concerning the qualities

ized objects and numerals: (3) Composite Portraits, an objective mode stracting the general characteristics of a number of objects.
: results obtained by Mr. Galton were considered as establishing a val- mode of psychological inquiry.

erations in Statistical Number, by B. I. GILMAN.

his paper, Relative Number was defined to be the average number per elations of the form x, which have relates or correlates among the y's. s shown that Relative Number, in which the relations concerned are re- s of identity, is what is known as Probability. From formulae which established at length for the addition, subtraction, multiplication and ition of Relative Number, a number of Theorems in Probabilities were :ed.

Study of a Portion of Hume's "Human Understanding," by . BURT.

slie Stephen on Causation, by G. S. MORRIS.

gelianism in St. Louis, read for the author by C. W. Nichols.

thematical Seminary.

ay Meeting.

Problem in Maxima and Minima, by R. W. PRENTISS.

determining the angle of minimum deviation of a ray of light through m, we can avoid the usual process of forming the differential coefficient, ing it to zero and solving the resulting equation, if we can show that n the conditions of the problem there is but one minimum.
a simple experiment (Ganot's Physics, pg. 446), it is shown that there is ne deviation less than any other. By the usual notation
$l = i + r' - i' - r \qquad i' + r = A \quad \therefore \quad d = i + r' - A.$
e equations expressing relations between i and r′ are by principles of :tion, n being index of refraction:

$$\begin{array}{ccc} \sin r' = n \sin i' & & \sin i = n \sin r \\ i' = A - r & \text{or} & r = A - i' \\ n \sin r = \sin i & & n \sin i' = \sin r'. \end{array}$$

om the symmetry of these relations it is evident that d can be expressed ecisely the same function of r′ as of i *i. e.* $d = f(r')$ or $d = f(i)$ where otes a definite function. Whatever value of i, then makes $d = f(i)$ a num must be a value of r′ that makes $d = f(r')$ a minimum, and since, own above, there is only one minimum, we must have, at that minimum, ′ the usual result.

Geometric Locus, by R. W. PRENTISS.

e locus of the vertex of a tetrahedron, each of whose faces passes gh a fixed point, and whose base edges move in fixed planes, is in gen- a surface of the third order having the intersection of the three fixed :s for a double point. If, however, the four fixed points lie in one plane, urface breaks up into a plane and a cone of the second degree.
note the fixed points P′, P″, P‴, P⁗, by their coördinates $(a', \beta', \gamma', \delta')$, $\beta'', \gamma'', \delta'')$, &c., &c. Let the fixed places be given by $a = o, \beta = o,$ o.
ie plane of the base may then be put into the form, $La + M\beta + N\gamma +$ here L, M, N, P are indeterminates, subject to condition $La'''' + M\beta''''$ $\gamma'''' + P\delta'''' = o$. The equations of the planes of the three faces which at the vertex are found to be

$$\begin{array}{rllll} (aa') & L + (a\beta') & M + (a\gamma') & N + (a\delta') & P = o \\ (\beta a'') & L + (\beta\beta'') & M + (\beta\gamma'') & N + (\beta\delta'') & P = o \\ \text{and } (\gamma a''') & L + (\gamma\beta''') & M + (\gamma\gamma''') & N + (\gamma\delta''') & P = o \\ \text{bove condition is } a'''' & L + \beta'''' & M + \gamma'''' & N + \delta'''' & P = o \end{array}$$

e we denote by $(a\beta')$, &c., the expressions $a\beta' - a'\beta$, &c.
iminating L, M, N and P from these equations, we obtain the equation ie locus. The result of elimination is a compound determinant of the h order, evidently reducing to a simple one of the fifth order, thus:—

$$\begin{vmatrix} (aa'), & (a\beta'), & (a\gamma'), & (a\delta') \\ (\beta a''), & (\beta\beta''), & (\beta\gamma''), & (\beta\delta'') \\ (\gamma a'''), & (\gamma\beta'''), & (\gamma\gamma'''), & (\gamma\delta''') \\ a'''', & \beta'''', & \gamma'''', & \delta'''' \end{vmatrix} = \begin{vmatrix} a, & \beta, & \gamma, & \delta, & 1 \\ aa', & a\beta', & a\gamma', & a\delta', & a' \\ \beta a'', & \beta\beta'', & \beta\gamma'', & \beta\delta'', & \beta'' \\ \gamma a''', & \beta\gamma''', & \gamma\gamma''', & \gamma\delta''', & \gamma''' \\ a'''', & \beta'''', & \gamma'''', & \delta'''', & 0 \end{vmatrix}$$

$\beta\gamma\,(a'\beta''\gamma'''\delta'''') - a'\beta\gamma\,(a\beta''\gamma'''\delta'''') + \beta''\gamma a\,(a\beta''\gamma'''\delta'''') - \gamma'''a\beta\,(a\beta'\gamma''$ $= 0$, developing according to last column and denoting by $(a'\beta''\gamma'''\delta'''')$, &c.; the determinants of coördinates of P′, P″, P‴, P⁗; &c., respect- . Substituting for a, β and γ, $\rho\lambda$, $\rho\mu$ and $\rho\nu$ respectively, the equation nes the form $A\rho^2 + B\rho^3 = 0$, showing that the intersection of a, β, γ is uble point of the surface. The surface passes through the four fixed points and contains the lines $[a, \beta]$, $[a, \gamma]$, $[a, (a\beta''\gamma'''\delta'''')]$, also $[\beta, \gamma]$, $[\beta, a\beta'\gamma'''\delta'''')]$, and $[\gamma, (a\beta'\gamma''\delta'''')]$ where $[a, \beta]$, &c., denote lines of intersection of $a = o$ and $\beta = o$, &c., respectively.

If the four points lie in one plane, $(a'\beta''\gamma'''\delta'''') = o$.

The expressions $(a\beta''\gamma'''\delta'''')$, $(a\beta'\gamma'''\delta'''')$ and $(a\beta'\gamma''\delta'''')$ which, equated to zero, are the equations of planes passing through three of the points, viz.: P″, P‴, P⁗; P′, P‴, P⁗; P′, P″, P⁗ respectively, are now the equation of the plane of the four points, and must therefore be multiples of the same linear function of a, β, γ, δ, say $l\triangle$, $m\triangle$ and $n\triangle$ respectively. The equation of the locus then becomes

$$\triangle(-la'\beta\gamma + m\beta''\gamma a - n\gamma'''a\beta) = O$$

$$\triangle = O \text{ (a plane)} \quad \text{or} \quad -la'\beta\gamma + m\beta''\gamma a - n\gamma'''a\beta = O \text{ which gives a cone.}$$

October Meeting.

A Deduction from the Properties of a System of Three Circles, by F. FRANKLIN.

The properties of a system of 3 circles and their orthogonal circle give, by projection, the following theorem: If 3 conics pass through 2 fixed points *P*, *Q*. the 3 junctions of the other two intersections of each pair of the conics meet in a point *R*; the 6 contacts of tangents from *R* to the 3 conics lie on a conic passing through *P*, *Q*; and the tangent to this conic at its intersection with any one of the 3 original conics cuts the line *P Q* in the harmonic conjugate with respect to *P* and *Q* of the point in which the tangent to the original conic at the intersection in question cuts *P Q*.—As a limiting case of this, let *P* and *Q* coincide; then the harmonic conjugate above-mentioned will coincide with them; hence the conic through the 6 points of contact has for its tangent at each of those points a line passing through *P*, itself a point of the conic; the conic must therefore be a pair of straight lines intersecting in *P*. Hence we have the theorem:

If 3 conics touch at a point *P*, the 3 chords of intersection of the conics taken in pairs meet in a point *R*, and the 6 contacts of tangents from *R* to the 3 conics lie by threes on 2 straight lines intersecting in *P*.

The theorem above demonstrated is virtually equivalent to a well-known theorem.

On the Properties of the Roots of $x^2 \equiv x$ mod. k, by O. H. MITCHELL.

Let $k = a^t b^u \cdot\cdot q^x$, the number of unequal prime factors, $a, b, \cdot\cdot q$ being i. Then among the 2^i roots of the congruence $x^2 \equiv x$ mod. k there will be one which is prime to k, one containing a and *not* $b \cdot\cdot\cdot q$, one containing only b, one containing only $a\,b$, &c., &c. These roots may therefore be represented by
$R_1, R_a, R_b, R_c, \cdot\cdot\, R_{ab}, R_{bc}, \cdot\cdot\, R_{abc}, \cdot\cdot\cdot$, the subscript denoting what unequal prime factors the root has in common with k. Thus if $k = 60$, $R_1 = 1$, $R_2 = 16$, $R_3 = 21$, $R_5 = 25$, $R_{2,3} = 36$, $R_{3,5} = 15$, $R_{5,2} = 40$, $R_{2,3,5} = 0$.

If s, s', s'', &c. are any combinations of the unequal prime factors of k, prime to one another, the following relations hold:

(1) $R_s R_{s'} \equiv R_{ss'}$ mod. k; thus $R_2 R_5 \equiv R_{2,5}$ mod. 60.

(2) $R_s + R_{s'} \equiv R_{ss'} + 1$ mod. k; thus $R_2 + R_5 \equiv R_{2,5} + 1$ mod. 60.

(3) $\Sigma_1^n R_s \equiv R_{ss's''\cdot\cdot s^{[n]}}$ mod. k; or, more generally still,

(4) $\Sigma R_{ss'\cdot\cdot s^{[r]}} \equiv \dfrac{\pi n}{\pi(n-r)\,\pi r} R_{ss's''\cdot\cdot s^{[n]}} + \dfrac{\pi n}{\pi(n-r+1)\,\pi(r+1)}$

$\therefore$ (5) $\Sigma^{2^i} R \equiv 2^{i-1}$.

(6) $R_{ss''s'''} - R_{s's''s'''} \equiv R_{s''} - R_{s's''} \equiv R_s - R_{s'}$. If we have $s\,s'\cdot s^{[n]} = w =$ the product of all the unequal prime factors of k, then (7) $R_{ss's\cdot\cdot s^{[n]}} \equiv 0$ mod. k.

$\therefore$ (8) $(R_s - R_{s'})^2 \equiv 1$, when $ss' = w$.

On v. Gall's Table of Groundforms for the Octavic, by F. FRANKLIN.

In Sylvester's table of the groundforms of the Binary Octavic (American Journal of Math., Vol. II., p 233), there are given 3 forms of degorder (7.6), 3 of degorder (9.2) and 2 of degorder (11.2). Proceeding by the method of Clebsch and Gordan, v. Gall finds one less in each of these degorders (see Mathem. Annalen, vol. xvii, p. 150). Mr. Franklin explained how the number of groundforms of a given degorder may be determined, and showed that the numbers given in Sylvester's table agree with those obtained by a direct consideration of the partitions involved, so that v. Gall's table conflicts with the fundamental theorem for the determination of the number of linearly independent covariants of a given degree and order.

P. S.—Since the meeting of the Seminary, Prof. Sylvester has received a letter from Mr. v. Gall, stating that he had discovered an oversight in his work, on correcting which the above disagreement is removed.

November Meeting.

Outline of Clebsch's and Gordan's Method of Finding the Groundforms of a Binary Quartic, by W. E. STORY.

J. R. McD. IRBY, Ph. D.

Late Fellow in the Johns Hopkins University.

Professor G. vom Rath, the distinguished Mineralogist, of the University of Bonn, recently read before the *Niederrheinischen Gesellschaft für Natur und Heilkunde*, in Bonn, a tribute to the memory of the late Dr. Irby, the substance of which is given in the following paper, by W. D. Booker, M. D., of Baltimore:

Dr. Irby was born August 4th, 1854, at Lynchburg, Va. He graduated at the University of Virginia, and went in 1875 to Heidelberg; the following year he came to Bonn, where he devoted himself to crystallography and mineralogy. Here he solved most creditably a prize problem proposed by the Philosophical Faculty of the University, in an essay which he afterwards published under the title of "The Crystallography of Calcite." In recognition of this work the University of Göttingen bestowed upon him the degree of Doctor of Philosophy. Accompanied by his young wife, whom he married in Bonn, he returned to the United States in 1878, and was employed in Washington by the United States Coast Survey upon the exposition of crystallographic methods of projection, and by the Smithsonian Institution in editing some manuscript notices of Smithson, saved from the conflagration of the Institution in 1860.

Dr. Irby had scarcely finished this work when the death of his father and mother, on the same day, in New Orleans, of yellow fever, caused him to hasten to that city, where he remained to prevent the sacrifice of his father's business for the sake of his two younger brothers. In July 1879, he received an appointment to a fellowship in the Johns Hopkins University, and moved to Baltimore to reside. There he made extensive preparations and plans for his future work. While holding his office at the University, he hoped to be able to carry out, during a three months' vacation, an examination, with which he was charged by the United States Geological Survey, into the most important mineral districts of the United States, particularly those of Lake Superior. Thus he hoped gradually to get into possession of the materials which were to form the foundation for the work to which he wished to devote his life—a treatise on the minerals of the United States. He intended to begin with calc-spar, for the study of which he was specially prepared. Professors Brush, of New Haven, and Egleston, of New York, loaned him forty magnificent calc-spar specimens from Lake Superior, which can hardly be obtained by purchase.

The theory of the calc-spar system, the scrutiny of its zones and of the planes lying in them, appeared to him to be the real centre and essence of crystallography. For several months he was engaged in elaborating his lectures and noting measurements, with Fuess's Goniometer, of calc-spar and some organic compounds in which he had recognized interesting relations between form and composition. In February 1880, an enticing prospect of mineralogical labor was opened to him, A financial company in New York charged him with the examination of a district in Chili, that he might form an intelligent opinion as to the prospect of a mining enterprise there. With quick readiness he accepted the charge, hoping to be able thoroughly to investigate a little known, almost virgin, territory. He sailed March 2d from New York. His last letter, dated Panama, March 17th, was full of hope and bright expectations. On the forenoon of March 25th he seemed perfectly well; in the afternoon of the same day he was found lifeless in his cabin, having died without a struggle or sign of pain, probably of some obscure heart disease. He was interred at Pacasmayo, Peru.

Thus science was robbed of a disciple of great promise, of keen observation, and full of enthusiasm; his friends have lost a friend of rare kindness of heart and faithfulness, his family an excellent husband, father, and brother. Irby's dissertation "On the Crystallography of Calcite" must necessarily be employed as the founda-[illegible]ll future investigations of this mineral, so rich in its forms. [illegible]o was several times a guest of this society, leaves with all who knew him the impression of a man of unusual po combining in himself qualities which are rarely found togethe one person, searching acuteness being united with childlike hi ness and purity of heart. His conversation, always the fai expression of his thoughts, was without guile and without prete

Some of the friends of Dr. Irby, in Germany, are making a tribution towards a fund for the education of his infant son. similar subscription will be begun in this country, and those desire to be informed in respect to it are invited to communi with Dr. W. D. Booker, 152 W. Madison Street, Baltimore.

Award of the Copley Medal.

The Royal Society has awarded to Professor Sylvester, of the Johns H kins University, Baltimore, the Copley medal, the highest distinction in t gift. I hear this was unanimously voted by the Council in recognition of originality and variety of Professor Sylvester's mathematical work, and valuable service in stimulating high mathematical study at Baltimore. T compliment was coupled privately with expressions of regret that Profes Sylvester's abilities have been transferred to America.—*From a London egram, by G. W. S., to the New York Tribune, Nov. 21, 1880.*

This medal was first given by the Society in 1753, to Dr. Benja Franklin. In the following list the names are recorded of those who h received this honor during the last twenty years:

1860.	R. W. Bunsen.	1870.	J. P. Joule.
1861.	L. Agassiz.	1871.	J. R. Mayer.
1862.	T. Graham.	1872.	F. Wöhler.
1863.	A. Sedgwick.	1873.	H. L. F. Helmholtz.
1864.	C. Darwin.	1874.	P. Pasteur
1865.	M. Chasles.	1875.	A. W. Hofman.
1866.	J. Plücker.	1876.	C. Bernard.
1867.	K. E. Von Baer.	1877.	J. D. Dana.
1868.	C. Wheatstone.	1878.	J. B. Boussingault.
1869.	V. Regnault.	1879.	R. J. E. Clausius.

The mathematical medallists in previous years have been: Waring (17 Ivory (1814); Gauss (1838); Sturm (1841); Chasles (1865); Plücker (18

Graduates of 1880.

DOCTORS OF PHILOSOPHY.

FRANCIS G. ALLINSON, *Burlington, N. J.*, A. B., Haverford, 1876, A. B., Harvard, 1877.

Thesis, On Ionic Forms in the Second Century, A. D., and the obligatio Lucian to Herodotus.

FABIAN FRANKLIN, *Baltimore*, Ph. B., Columbian, 1869.

Thesis, On Bipunctual Co-ordinates.

EDWIN H. HALL, *Gorham, Me.*, A. B., Bowdoin, 1875.

Thesis, On the New Action of Magnetism on a Permanent Electric Curr

ALLAN MARQUAND, *New York City*, A. B., Princeton, 1874.

Thesis, The Logic of the Epicureans, with a translation of a treatis Philodemus.

WASHINGTON I. STRINGHAM, *Topeka, Kansas*, A. B., Harvard, 1877.

Thesis, On Regular Figures in *n* dimensional Space.

BACHELORS OF ARTS.

THOMAS M. BEADENKOPF, . . .	*Baltimore.*
A. KERR BOND, ...	*Harford County.*
WILLIAM C. DAY, ...	*Baltimore.*
HENRY L. GANTT, ...	*Owings Mills.*
EDGAR GOODMAN, ...	*Baltimore.*
CARL E. GRAMMER, . . .	*Baltimore.*
ALEXANDER F. JAMIESON, . .	*Alexandria, Va.*
EDMUND A. JARVIS, . . .	*Baltimore.*
STEWART B. LINTHICUM, . .	*Baltimore.*
JOHN H. LOWE, ...	*Baltimore.*
LEIGH C. MORGAN, . . .	*Baltimore.*
NELSON PALMER, ...	*Baltimore.*
THOMAS PETTIGREW, . . .	*Hillsboro', N. C.*
HARRY F. REID, ...	*Baltimore.*
W. RAYMOND STRICKLEN, . .	*Baltimore.*
LEWIS W. WILHELM, . . .	*Baltimore.*

Baltimore Naturalists' Field Club.

Baltimore Naturalists' Field Club was founded on the eighth of last
by members of the University, in order to endeavor to meet the recog-
vant in the city of some organization for the active promotion of field
ı Natural History. Professor H. Newell Martin was elected President,
r. E. M. Hartwell, Secretary. The objects of the club are to study the
, Flora, Geology and Physical Geography of the Baltimore district and
ınd preserve collections illustrative of the same.

he first meeting of the club, it was voted to form sections on Botany,
c Animals, Invertebrate Land Animals, Vertebrate Land Animals, and
;y and Physical Geography. The following gentlemen were chosen
en of the respective sections: Mr. W. T. Sedgwick; Dr. S. F. Clarke;
. B. James; Dr. W. A. Moale; and Mr. E. B. Wilson. Each chairman
owered to select a committee of three, to specially act with him in
ıg on the work of his section.

members of the University, and residents of Baltimore of known
nents as naturalists are eligible for election to the club. The member-
as nearly doubled since the society begun, with twenty-two original
ers; of those who have since joined about half are not connected with
niversity. Field meetings are held every fine Saturday during the
r periods of the academic year. Monthly meetings, to consider the
s of chairmen of the various sections, and discuss the general results
ceding excursions, are also held. On the occasion of its first field
ıg, on April 17, the club visited Clifton and Montebello. On subse-
occasions, excursions have been made to the Spring Gardens district;
gion north of Woodberry; the Valley of Gwinn's Falls; the Marine
tal neighborhood; that part of the Valley of the Patapsco between
:lay House and Ilchester; and to Pen-Mar.

ı special meeting, held in Hopkins Hall, May 24, Mr. P. R. Uhler,
ent of the Maryland Academy of Sciences, gave a general description
features of the high tongue of land lying between the middle and
vest branches of the Patapsco. He said that the soil of this region
erived from decomposed drift, subsequently recomposed, and from the
of an ancient swamp, which once contained numerous *Cycads* and
He showed that the whole region had been formed during the Jurassic
by deposits of material transported from high mountains adjoining on
rth. The present features of the region he held to be due to water
in Post-Jurassic time, in which the ocean seemed to have had no part.

s far the efforts of the club have been directed, mainly in its field
ıgs, to familiarizing its members with the general topographical features
regions adjacent to Baltimore, and to ascertaining the best localities
lecting.

:t season it is proposed that each section work independently and in a
letailed method than has been possible hitherto. Every step thus far
ıphasized the need of a topographical map of the suburban districts.

Teachers' Class in Latin.

achers' class for the study of the Elements of the Latin Language,
cted by PROFESSOR CHARLES D. MORRIS, was formed on Saturday,
er 23, 1880, at 10 A. M., in Hopkins Hall, and is to meet on successive
lays, at the same place and hour, until twenty lessons have been given.
session lasts about two hours.

: class is intended for those only who have no knowledge of the sub-
hatever, but are desirous of acquiring it with as small an expenditure
ıe and labor as may be.

the system pursued may be novel to many who are engaged in the
of teaching Latin, Professor Morris is glad to welcome as auditors a
number of teachers interested in observing what can be effected by
ethod.

: next number (Vol. I., No. 4) of the AMERICAN JOURNAL OF PHILOLOGY
ontain articles as follows:

the Codex Neapolitanus of Propertius, by ROBINSON ELLIS.
erfect and Pluperfect Subjunctive in Roman Folk-speech, by E. A. FAY.
Parodos of Aristophanes' Vespae, by F. G. ALLINSON.
blems of Semitic Philology, by C. H. TOY.
Agamemnon of Aeschylus, by LEWIS CAMPBELL.
tic and Germanic, by JAMES M. HART.

ı meeting of the British Association for the Advancement of Science,
October 8, 1880, the committee for the Calculation of Tables of the
ımental Invariants of Algebraic Forms, consisting of Professors Syl-
, Cayley, and Salmon, were reappointed, and the sum of 40 l. was placed
ir disposal.

Fellowships.

The following persons have been recently invited to become Fellows in the place of Messrs Nichols and Rowland resigned.

In Chemistry, Mr. ROBERT DORSEY COALE, of Baltimore, for the last four years a student in this University.

In Biology, A. F. W. SCHIMPER, Ph.D., of the University of Strassburg. Dr. Schimper has resigned a position which he held in the Museum of Natural History at Strassburg, Elsass, in order to come to Baltimore.

Fellows by Courtesy.

By a vote of the Academic Council, the following names will be enrolled on the list of Fellows by Courtesy, during the coming year.

LAWRENCE B. FLETCHER, A. B., late a Fellow of Columbia College.
ALLAN MARQUAND, Ph.D., late a Fellow in this University.
EDWARD L. NICHOLS, Ph.D., late a Fellow in this University.
HENRY A. SHORT, A. B., a Fellow of Columbia College.

Graduate Scholarships.

The Trustees of the Johns Hopkins University, last summer, agreed to offer during the coming academic year a number of graduate scholarships. Three of these were awarded, June 10, 1880, to the following members of the graduating class, in recognition of the ability they had shown as undergraduate students:

WILLIAM C. DAY, of Baltimore.
HENRY L. GANTT, of Baltimore.
HARRY F. REID, of Baltimore.

Mr. Gantt subsequently gave up the scholarship to accept the post of an instructor in the McDonogh School, Owings Mills, Md.

A fourth scholarship was awarded at the same time to a resident graduate. CHARLES H. KOYL, of Cobourg, Ontario, a graduate of Victoria University, Ontario.

Early in the present session two more of the scholarships were awarded, for high attainments, to the following graduates:

SAMUEL C. DERBY, of Antioch, Ohio, a graduate of Harvard College.
HENRY N. STOKES, of Moorestown, N.J., a graduate of Haverford College.

The principles which governed the award were nearly the same as those which have been observed in bestowing the fellowships.

The bestowal of the vacant scholarships will be considered by the Academic Council (consisting of the President and Professors) early in January next.

Brief Announcements.

FRANCIS G. ALLINSON, Ph.D., late Fellow in Greek, has been appointed Assistant Professor of Greek and Latin in Haverford College.

LYMAN B. HALL, Ph.D., late Assistant in the Chemical Laboratory here, has been appointed Professor of Chemistry and Physics, in Haverford College.

Mr. P. B. MARCOU, A.M., of Harvard College, has been appointed an instructor of the major and minor courses in French. Mr. Marcou was born in France and received in Paris his early education.

Mr. G. H. STOCKBRIDGE, A.M., of Bates College, Me., is giving instruction, during the current year, in Latin and German. He was previously an instructor in Amherst College.

In addition to the classes enumerated on previous pages of this Circular a class in Drawing, conducted by Mr. HUGH NEWELL, Instructor in Drawing in the Maryland Institute, has been formed and meets twice weekly in the rooms of the Biological Laboratory.

The FIFTH ANNUAL REPORT OF THE PRESIDENT of the University, for the year ending Sept. 1, 1880, was presented to the Trustees at their regular meeting in October, and is now in press,—nearly ready to be issued. It will contain a review of the work of the year, with the usual statistical appendix.

At a meeting of the Board of Trustees, held October 4, 1880, the President of the Board called the attention of the Trustees to a portrait of the Founder, recently painted by Mr. LeClear, of New York, and presented to the University, in June last, by Mr. John W. Garrett, whereupon, on motion it was *resolved*: That the gift by Mr. Garrett to this University of the portrait of the late Johns Hopkins, a picture admirable both as a work of art and as a faithful likeness of the founder of the University, is gratefully acknowledged by the Board; and the President of the Board of Trustees is requested to acknowledge the gift, and convey to Mr. Garrett the thanks of the Trustees; and the President of the University is requested to give it a prominent place in the building of the University.

UNIVERSITY ROOMS AND HOURS.

The rooms marked by numbers are in the University Buildings, corner of Howard and Ross Streets, and those indicated by letters are in 113 West Monument Street, betwe and Garden Streets.

Consultation Hours.

Saturdays and Sundays are excepted.

The President and members of the Academic Staff will receive students and other persons desiring to consult them, at the hours and places indicated in the following schedule.

For the economy of time, on the part both of the Faculty and of the students, it is particularly requested that official consultations be made, except in special emergencies, as appointed below.

PRESIDENT GILMAN is seldom absent from the buildings between 9. A. M. and 2 P. M., and is often in his office during the afternoon. Routine business and matters of minor importance may be brought to his attention orally, between 12 and 1 P. M., or at other times by notes and memoranda left with the clerk in the Registrar's office.

ADAMS, H. B., Associate in History, *Registrar's Office*, 9 A. M., and 5 P. M.
ADAMS, H. C., Lecturing on Political Economy, *Registrar's Office*, 9 A. M.; 132 *W. Madison St.*, 12 M.
BRANDT, H. C. G., Associate in German, *Room A*, 11 A. M.
BROOKS, W. K., Associate in Biology, *Biological Laboratory*, 10 A. M.
BROWNE, W. H., Librarian, *Library*, 9 A M.–5 P. M.
COOK, A. S., Associate in English, *Room B*, 4 P. M.
CLARKE, S. F., Assistant in Biology, *Biological Laboratory*, 10 A. M.
CRAIG, THOMAS, Lecturing on Mathematics, *Room* 16, *Tuesday, Thursday and Friday*, 4 P. M.
CROSS, J. M., Associate in New Testament Greek, *Room F*, 10 A. M.
ELLIOTT, A. M., Associate in Modern Philology, *Room B*, 1 P. M.
FRANKLIN, F., Assistant in Mathematics, *Room* 16, 12 M.
GILDERSLEEVE, B. L., Professor of Greek, *Room* 14, 11 A. M.
HASTINGS, C. S., Associate in Physics, *Room* 4, 11 A. M.
MARCOU, P. B., Assistant in French, *Room C*, 1. P, M.
MARTIN, H. N., Professor of Biology, *Biological Laboratory*, 12 M.
MORRIS, C. D., Professor of Greek, *Room B*, 11 A. M.
MORSE, H. N., Associate in Chemistry, *Chemical Laboratory*, 11 A. M.
PEIRCE, C. S., Lecturer on Logic, *Room C*, 9 A. M.
REMSEN, IRA, Professor of Chemistry, *Chemical Laboratory*, 11 A. M.
ROWLAND, H. A., Professor of Physics, *Physical Laboratory*, 9 A. M.
SEWALL, HENRY, Associate in Biology, *Biological Laboratory*, 12 M.
STOCKBRIDGE, G. H., Assistant in Latin, etc., 209 *N. Howard Street*, 2 P. M.
STORY, W. E., Associate in Mathematics, *Room* 15, *Tuesday, Wednesday and Thursday*, 11 A. M.
SYLVESTER, J. J., Professor of Mathematics, *Room* 17, *Tuesday and Friday*, 2 P. M.; *Mt. Vernon Hotel*, *daily*, in the morning.
WARREN, MINTON, Associate in Latin, 123 *W. Madison Street*, 2 P. M.
WOODWORTH, C. L., Instructor in Vocal Culture, *No.* 205 *N. Howard Street*, 2.30 P. M.

Treasurer's Office.

MR. C. J. MEYER will be in attendance in the Treasurer's Offic University Buildings, 9 to 11 A. M., 3 to 5 P. M.

Registrar's Office.

This office is open daily, except Saturdays, from 9 A. M. to 5 P. on Saturdays from 9 A. M. to 3 P. M., and from 4 to 4.30 P. M.

Receipt and Departure of Mails, Etc.

(*Including Saturdays*).

Mails are received from the Post-office at 9 A. M. and 4 P. M.
Mails are sent to the Post-office at 8 A. M., and 3 P. M.
Mails are sent to the Street Letter-Box at 12 M. and 6 P. M.

☞ Memoranda, notes, letters and parcels may be left at the Re office to be distributed at 9 A. M. and 4 P. M.

Library and Laboratories.

The Library is open daily, including Saturdays, from 9 A. M. to

The Biological Laboratory is open daily, excepting Saturdays, from to 5 P. M.

The Chemical Laboratory is open daily, excepting Saturdays, from to 5 P. M.

The Physical Laboratory is open daily, including Saturdays, from to 5 P. M.

PEABODY INSTITUTE LIBRARY, (corner of Mt. Vernon an ington Places), contains 70,000 volumes, and is open daily, from 9 9 P. M.

MERCANTILE LIBRARY, (corner St. Paul and Saratoga Stre tains 40,000 volumes. The Library and Reading Rooms are op to members, from 9 A. M. to 10 P. M. Subscription, five dollars pe

MARYLAND HISTORICAL SOCIETY LIBRARY, (corner and Saratoga Streets), contains over 15,000 volumes, and is op 10 A. M. to 2 P. M.

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April 15–18.	**Spring Recess.**

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Mr. Lanier, Wednesdays, beginning January 12, (twelve lectures).

Professor Martin, Monday, Tuesday, Thursday, Friday, January 17–21.

Dr. Hastings, Monday, Tuesday, Thursday, Friday, January 24–28.

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Page, James	Baltimore.	77 *W. John St.*	Baltimore City College. *Matriculate.*
Palmer, Albert G.	Baltimore.	172 *McCulloh St.*	Mr. E. M. Lamb's School. *Matriculate.*
Palmer, Nelson	Baltimore.	96 *Townsend St.*	A. B., Johns Hopkins University, 1880. *History and Political Science.*
Patterson, J. Wilson	Baltimore.	79 *Park Ave.*	A. B., Princeton College, 1863. *Latin and History.*
Pennington, Clapham	Baltimore.	36 *W. Eager St.*	*Chemistry.*

Peterson, James B. South Abington, Mass. 288 *W. Biddle St.*
Philosophy.

Pickle, James M. Williamston, S. C. 82 *N. Greene St.*
A. M., Furman University, 1876. *Physics and Mathematics.*

Prescott, Philip M. Waukegan, Ill. 48 *Cathedral St.*
Chandler Scientific Department, Dartmouth College. *Languages.*

Price, Herbert L. Baltimore. 70 *Bolton St.*
Baltimore City College. *Preliminary Medical.*

Pund, Frederick Baltimore. 282 *N. Gay St.*
Mr. C. P. Grady's School. *Candidate.*

Ramage, Bartow B. Newberry, S. C. 151 *McCulloh St.*
A. B., Newberry College, 1880. *History, etc.*

Ramage, Burr J. Newberry, S. C. 151 *McCulloh St.*
A. B., Newberry College, 1880. *History, etc.*

Read, Miles S. Baltimore. 216 *Mosher St.*
Crozer Theological Seminary. *Philosophy and Greek.*

Reese, Charles L. Baltimore. 495 *Madison Ave.*
Baltimore City College. *Candidate.*

Reese, Robert M. Baltimore. 209 *W. Pratt St.*
Mr. E. M. Lamb's School. *Matriculate.*

Reid, Harry F. Baltimore. 75 *Mt. Vernon Place.*
A. B., Johns Hopkins University, 1880. *Biology and Physics.*

Robinson, Adoniram J. Baltimore. 192 *Mulberry St.*
Baltimore City College, 1879. *Matriculate.*

Robinson, Carvel H. Baltimore. *Charles and Townsend Sts.*
Dr. R. Atkinson's School *Matriculate.*

Rolando, Henry Baltimore. 383 *Park Ave.*
Baltimore City College. *Matriculate.*

Sale, Lee Louisville, Ky. 86 *N. Stricker St.*
Louisville High School, 1878. *Matriculate.*

Seelye, William J. Amherst, Mass. 28 *McCulloh St.*
A. B., Amherst College, 1879. *Greek.*

Shippen, Charles C. Baltimore. 189 *North Charles St.*
A. B., Harvard University, 1877; M D, University of Maryland, 1879. *Biology.*

Stebbins, Frank E. Springfield, Mass. 288 *W. Biddle St.*
A. B., Amherst College, 1880. *Philosophy.*

Stevens, Lewis T. Baltimore. 105 *Charles St. Ave.*
Baltimore City College. *Matriculate.*

Stokes, Henry N. Moorestown, N. J. 128 *W. Madison St.*
S. B., Haverford College, 1878. *Chemistry.*

Stratton, William E. Baltimore. 66 *N. Liberty St.*
Baltimore City College. *Preliminary Medical.*

Taylor, Amzi D. Newark, N. J. 22 *Cathedral St.*
Princeton College. *Latin and Greek.*

Taylor, Percy H. Baltimore Co. 257 *Linden Ave.*
Princeton College. *Romance Languages.*

Thach, Charles C. Athens, Ala. 19 *McCulloh St.*
B. E., Alabama Agricultural College, 1877. *Languages.*

Thomas, Henry M. Baltimore. 317 *Madison Ave.*
Haverford College. *Preliminary Medical.*

Tidball, Charles M. Greensboro, N. C. 248 *Bolton St.*
University of Virginia. *Latin and Greek.*

Tidball, William J. Greensboro, N. C. 248 *Bolton St.*
A. B., Davidson College, 1878. *Greek.*

Tiffany, Herbert T. Baltimore. 85 *Bolton St.*
Mr. S. E. Turner, Instructor. *Matriculate.*

Trimble, Isaac R. Longwood. 241 *Maryland Ave.*
Shenandoah Valley Academy. *Preliminary Medical.*

Warfield, Mactier Baltimore. 112 *St. Paul St.*
Ury House School. *Matriculate.*

Warren, Henry C. Newtonville, Mass. 132 *W. Madison St.*
A. B., Harvard University, 1879. *Chemistry.*

Wiegand, Henry H. Baltimore. 272 *Madison Ave.*
Baltimore City College. *Chemistry and Physics.*

Wilhelm, Lewis W. Baltimore. 64 *Pennsylvania Ave.*
A. B., Johns Hopkins University, 1880. *History and Political Science.*

Wilson, Henry V. Baltimore. 314 *Linden Ave.*
Baltimore City College. *Matriculate.*

Worthington, J. Cheston St. Denis. *South and German Sts.*
M. D., University of Maryland. *Chemistry.*

Wylie, H. Boyd Baltimore. 225 *Argyle Ave.*
M. D., Bellevue Hospital Medical College, N. Y., 1878. *Chemistry.*

Young, Abram V. E. Grand Rapids, Mich. 85 *McCulloh St.*
Ph. B., University of Michigan, 1875. *Chemistry.*

In addition to others above enrolled, the persons below named were members of the Chesapeake Zoölogical Laboratory *during the Summer of 1880.*

King, F. W. River Falls, Wis.
Professor of Natural Science, Wisconsin State Normal School.

Evarts, H. C. Philadelphia.
M. D.; Academy of Natural Sciences, Philadelphia.

Osborn, Henry F. Princeton, N. J.
A. M., Sc. D., and Fellow of Princeton College.

The following were attendants, with others above enumerated, upon the Summer Class at Fort Wool, during July and August, 1880.

Gordon, Henningham Baltimore.
A. B., St. John's College, 1873; Tutor in the Baltimore City College.

Rider, Wheelock Rochester, N. Y.
University of Rochester, N. Y.

SUMMARY.

President and Professors,	7
Lecturers,	6
Associates,	15
Assistants,	7

Students.

Graduate Students (including Fellows),	89
Matriculates,	30
Students not Matriculated,	49
	168

Classification by Residence of Students, 1880-81.

Maryland, (Baltimore, 75),	91
New York,	14
Massachusetts,	9
Pennsylvania,	7
Kentucky,	6
Ohio,	5
New Jersey,	4
North Carolina,	4
Illinois,	4
South Carolina,	3
Michigan,	3
Virginia,	2
Georgia,	2
Wisconsin,	2
Japan,	2
Ontario, (Canada),	2
New Hampshire,	1
Connecticut,	1
District of Columbia,	1
Florida,	1
Alabama,	1
Minnesota,	1
France,	1
Germany,	1

Students now enrolled here have received Degrees from the Institutions below named:

Johns Hopkins University,	12
Amherst College,	8
Harvard University,	6
Cornell University,	3
Davidson College,	4
Maryland, University of,	5
Virginia, University of,	4
Michigan, University of,	3
Princeton College,	3
Williams College,	3
Yale College,	2
Centre College, (Ky.),	2
Columbia College,	2
France, University of,	2
Furman University,	2
Newberry College,	2
Rutgers College,	2
St. John's College,	2
Alabama Agricultural College,	1
Bellevue Hospital Medical College,	1
Boston University,	1
Georgia, University of,	1
Geneva College, (Ohio),	1
Göttingen, University of,	1
Hamilton College,	1
Hampden-Sidney College,	1
Haverford College,	1
Kentucky Wesleyan College,	1
Lafayette College,	1
Lehigh University,	1
London, University of,	1
Marietta College,	1
Norwegian Luther College,	1
Randolph Macon College,	1
Rochester, University of,	1
Strassburg, University of,	1
Syracuse University,	1
Tokio, University of,	1
Ursinus College, (Pa.),	1
Victoria University, (Ont.),	1
Wooster University,	1

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

Published here.

American Journal of Mathematics. Editor in Chief, Professor Sylvester; Associate Editor in Charge, Dr. Story. *Vol. III. No.* 2, 1880.

Article I.—Orthomorphic Projection of an Ellipsoid upon a Sphere. By Thomas Craig.

"After the labors of such men as Gauss, Lagrange, and Lambert, upon the general theory of orthomorphic projection, or projection by similarity of infinitesimal areas, it does not seem as though much of value or interest could be obtained by any further study of the subject, and indeed there is nothing more to be said upon the general theory, but an abundance of opportunities still exists for applying the results obtained by these princes of the realm of mathematics to the solution of particular cases of the problem. Boole, in the supplementary volume to his Differential Equations (a posthumous work, edited by Todhunter), gives a most elegant investigation of orthomorphic projection upon a plane; the formulae arrived at are applicable to any surface which it may be desired to project upon a plane. One application is made by Boole to the case of an oblate spheroid such as the earth. I have given in another place an application of his formulae to the projection of the general ellipsoid upon a plane, and the results obtained there led me to attempt the projection of the ellipsoid upon a sphere. Gauss gives, among the examples illustrative of his general theory, the projection of an ellipsoid of revolution upon a sphere, and considers the so-solved problem to be a valuable addition to geodesy. At the present day, when it is at least considered possible that the earth may be a general ellipsoid, it may be that the formulae necessary for its projection upon a sphere will not be regarded as devoid of interest."

Article II.—On the Calculation of the Generating Functions and Tables of Groundforms for Binary Quantics. By F. Franklin.

The scope of this article may be indicated by quoting the opening sentences. "The object of this paper is to give an account of the methods, due to Professors Cayley and Sylvester, of calculating the generating functions pertaining to binary quantics, and thence determining the number of fundamental invariants and covariants of any order and degree. As it will not very greatly increase the length of the paper, I shall endeavor, besides giving the processes of calculation, to present a connected view, though not a complete discussion of the subject."

The theory of the subject, and its working methods, have appeared in a fragmentary way, chiefly in the papers written by Professor Sylvester in the last four years, and these gave in many instances rather an intimation than an exposition of the principles and methods employed; so that it has been difficult for any one to ascertain the present state of the investigation. It was chiefly to supply this want that the present article was written. It also supplies the demonstrations, not hitherto published, of some theorems relating to the *form* of the generating functions and made use of in obtaining them. Finally, it should be mentioned that under the head "Mode of obtaining the Table of Groundforms," a demonstration, based on a certain fundamental postulate, is given of the correctness of the method of finite tamisage; and that the fundamental postulate which it was found necessary to adopt does not precisely coincide with that assumed by Professor Sylvester.

Article III.—Notes on Modern Algebra. By Cav. Faà de Bruno.

1. *Application du Théorème donné par l'Auteur sur le Développement des Fonctions.*

If ϕ is a covariant of the order m of a binary quantic $f = (a_0, a_1, \ldots a_n)(x, y)^n$, and if $\delta = a_0 \frac{d}{da_1} + 2a_1 \frac{d}{da_2} + 3a_2 \frac{d}{da_3} + \ldots$, and c_m is the last coefficient of ϕ, then $\phi = e^{x\delta}c_m$. We shall therefore obtain ϕ by the substitution in c_m of a_0, $a_1 + a_0x$, $a_2 + 2a_1x + a_0x^2$, $a_3 + 3a_2x + 3a_1x^2 + a_0x^3$, . . . for $a_0, a_1, a_2, a_3, \ldots$ respectively.

2. *Sur un Théorème dans les Déterminants.*

If Δ is any operation whatever, and we form the determinant

$$D = \begin{vmatrix} A, & \Delta A, & \Delta^2 A, & \ldots, & \Delta^n A \\ B, & \Delta B, & \Delta^2 B, & \ldots, & \Delta^n B \\ \ldots & \ldots & \ldots & \ldots & \ldots \end{vmatrix};$$

then, if $\Delta^n A$, $\Delta^n B$, . . . are constants relatively to the operation Δ, so that $\Delta^{n+1}A = 0$, $\Delta^{n+1}B = 0$, . . . , we shall have $\Delta D = 0$.

3. *Sur une Propriété du Jacobien.*

4. *Pour faire Suite à la Demonstration du Jacobien.*

Proof of the theorem: *The square of the Jacobian of two given quantics is a homogeneous quadratic function of these quantics.*

5. *Sur la Résolution de la Quartique.*

Every quartic can be reduced to the canonical form $x^4 + 6\mu x^2y^2 + y^4$. This note contains a determination of the coefficient μ in terms of the coefficients of the general quartic.

6. *Résolution de la Quintique dans le Cas où* $I_{18} = 0$.

The solution is derived from the canonical form $lx^5 + my^5 - n(x + y)^5 = 0$.

Article IV.—On General Differentiation. By J. Hammond.

"Assuming $D^nx^m = \frac{f(m+1)}{f(m-n+1)} x^{m-n}$,

we see at once (on writing $n = 1$) that $f(m + 1) = mf(m)$. This result is given by nearly every writer on the subject, most of whom assume some particular value for $f(m)$. . . . . In fact, the general solution of $[f_{(m+1)} = mf_{(m)}]$ considered as a difference-equation is $f(m) = C_m\Gamma(m)$, where $C_{m+1} = C_m$ . . . ."

The author deduces numerous general formulae, and makes interesting applications of them to Peacock's case, for which $C_m = 1$, Liouville's case, for which $C_m = (-)^{m-1} \frac{\sin m\pi}{\pi}$, and the case for which $C_m = \cos 2m\pi$. The paper concludes with a proof of Leibnitz's Theorem which does not assume $D^ne^{ax} = a^ne^{ax}$.

Article V.—Notes on Relative Motion. By James Loudon.

The following points are considered:

1. Motion of a point in a plane.
2. Motion of a rigid body round a fixed axis.
3. Measurement of the absolute velocity and acceleration of a point referred to axes moving in space round a fixed origin.
4. Extension of (3) to the case in which the origin moves.
5. Measurement of the changes in the rotation of a rigid body with one point fixed, the axes moving as in (3).
6 Measurement of the change in the whole absolute momentum of a rigid body in the same case.
7. Measurement of the changes in the whole absolute moment of momentum under the same circumstances.

Article VI.—On Certain Ternary Cubic-Form Equations. By J. J. Sylvester.

Chapter I. *Excursus C.*—On the Trisection and Quatrisection of the roots of unity.

In this article the Author obtains the equations for periods of three and of four roots of unity to a prime-number index (which have hitherto been obtained either by very long processes after the methods of Gauss and Kummer, or by indirect reasoning after the method of Jacobi) by a very simple process from first principles with the aid of the well known law that every whole-number rational integral function of the periods, which changes neither its absolute magnitude nor sign when a circular substitution is operated upon the roots, is an integer number, and of the law (an immediate consequence of the preceding one) that such function, if it changes its sign but preserves its absolute magnitude for circular substitution, is an integer multiple of the square root of the index or of the index with its sign changed according as when divided by 4 it leaves a residue plus or minus unity. There is a preliminary investigation in which it is shown that all the coefficients in the equation to what may be termed the *affected* periods of the roots of unity (except the first, which is unity) are divisible by the index. If p is the index and e the number of periods and η any one of them, $e\eta + 1$ is what he means by an *affected* period.

Excursus B.—Title 5 (*bis*).

In this article the author recasts the demonstration of the "law of squares" given in the preceding number of the *Journal*, which was defective and erroneous (having been printed during his absence in Europe without the proof-sheet passing under his eyes), and (by a mixture of algebraical and geometrical reasoning) supplies a demonstration of the law by no means easy but which he believes to be unexceptionable.

Starting from the equation $x^3 + y^3 + z^3 + kxyz = 0$, and supposing x, y, z to be one system of values by which it is satisfied, there exists an infinite number of sets of values X, Y, Z (obtainable by a definite process or rather any one of a catena of processes) each of them rational integer functions of x, y, z which must also satisfy the same equation.

The object of "the law of squares" is to show that the orders of these successive sets in the original quantities x, y, z, when expressed in their simplest terms are the squares of the successive numbers in the natural scale 1, 2, 3, 4, . . . , *ad inf.*

It is morally certain, but awaits proof, that no process whatever will supply values of X, Y, Z other than those which appear in the above chain.

It was comparatively easy to show that the derivative set x_n, y_n, z_n may be expressed as quantics of the order n^2 in x, y, z. The difficulty (a case of the proverbial one of proving a negative) consisted in showing that there cannot, for any value of n, exist an algebraic factor common to x_n, y_n, z_n so expressed.

Article VII.—Note on a Theorem for Expanding Functions of Functions. By EMORY MCCLINTOCK.

Mr. McClintock acknowledges the substantial anticipation, twenty years ago, by Mr. S. Roberts, F. R. S., of a theorem given by him in Vol. II of this *Journal.*

Article VIII.—Change of the Independent Variable. By J. C. GLASHAN.

The coefficients of powers of h in the development of $f(y + h)$ are expressed as determinants in terms of x, where $x \equiv \phi(y)$.

Article IX.—Note on the Intersections of Two Curves. By F. FRANKLIN.

"In Salmon's 'Higher Plane Curves' (p. 16), the theorem is given that if of the n^2 points of intersection of two curves of the nth order np lie on a curve of the pth order, a curve of the $(n-p)$th order may be passed through the remaining $n(n-p)$ of the points. It can likewise be proved" as is here done, "that if of the mn intersections of two curves of the mth and nth orders, np lie on a curve of the pth order (where $m > n$ and $m > p$), a curve of the $(m-p)$th order can be passed through the remaining $n(m-p)$ intersections."

The American Journal of Philology. Edited by PROFESSOR GILDERSLEEVE. Vol. I, No. 4, 1880.

Article I.—On the Neapolitanus of Propertius. By ROBINSON ELLIS.

Mr. Ellis characterizes the scope and treatment of the MSS. of Propertius by the revolutionary Bährens and the conservative Palmer. He considers it a real error in Bährens to discard all MSS. as useless of which he cannot confidently pronounce that they are uninterpolated. Interpolation is a matter of degree. On this ground, Mr. Ellis justifies Palmer in publishing a collation of the undeniably interpolated *Perusinus*, and while admitting the Lachmannian principle of determining the intemerate sources and the archetypal tradition, he maintains the value of some of the MSS. which are ruthlessly rejected. Then follows an account of the four MSS. of Propertius—AFDV, from which alone, according to Bährens, the archetypal reading is to be restored. N, a Neapolitan MS. held in high esteem by Heinsius, Lachmann, Herzberg, and Haupt, is rejected by Bährens, whose views have been briefly combated by Palmer and now more fully by Mr. Ellis, who produces. (1) Readings found in N, not in AFDV, which, on internal grounds, *cannot have been introduced* by an interpolator. (2) Readings found in N alone, not in (A)FDV which it is easier to explain as descending from an earlier MS. than as corrections of the XVth century. (3) A number of cases in which N presents the right reading against AFDV, but in which the hypothesis of a correction is conceivable, though not likely to be true. (4) Evidence of the sincerity of N from the orthography.

Article II.—A Proposed Re-distribution of the Parts in the Parodos of the Vespae. By F. G. ALLINSON.

An abstract of this paper, which was read before the Johns Hopkins Philological Association, is given in the University Circular for April, 1880, page 47.

Article III.—Imperfect and Pluperfect Subjunctive in the Roman Folk-Speech. By E. A. FAY.

Of the classical form of the Latin Imperfect Subjunctive the Romance even in the oldest monuments affords no trace whatever. Did this form exist in the unwritten speech of the common people of the old Roman world? This question Mr. Fay is inclined to answer in the negative, summing up the testimony thus:

1. The classical form of the Imperfect Subjunctive probably did not exist among the common people and its place is now supplied by the Pluperfect form. 2. The Pluperfect idea was probably expressed sometimes by the simple Pluperfect Tense and sometimes by a compound of the Past Participle with the Pluperfect Subjunctive of *habere* or some other auxiliary.

Article IV.—Problems of General Semitic Grammar. By C. H. TOY.

In this paper Professor Toy presents some of the morphological questions that require solution in the department of general Semitic grammar, taking up, 1. the phonology, 2. the subject of triliteral roots, 3. the formation and inflexion of stems and under this head, *a.* the history of the development of the noun, *b.* of the pronoun, *c.* of the verb.

Article V.—Notes on the Agamemnon of Aeschylus. By LEWIS CAMPBELL.

In the first part of this essay Professor Campbell discusses the fact that Aeschylus nowhere mentions Mycenae and calls attention to the points in the Oresteia, wherein "Aeschylus assumes a conception of the circumstances of the 'tale of Pelops' line' which differs from that which may be confidently spoken of as common to Homer and Sophocles." In the second part some forty passages of the Agamemnon are emended, interpreted or illustrated.

Article VI.—Keltic and Germanic. By J. M. HART.

After stating the famous theory of Bang as to the Sibylline origin of the Voluspá and conceding the force of the new interpretation, the writer of this paper questions the soundness of the conclusion which Bang has reached as to the source of this Sibylline element. "Keltic Ireland," says Bang, "is evidently the intermediary between the Voluspá and the Sibylline oracles." Professor Hart thinks that there is not a scrap of historical or linguistic evidence in favor of this view, and shows that the sweetness and meekness of the Columbian church which Vigfusson is reminded of by a passage in the Voluspá is not borne out by the Irish stories of St. Colum Cillé. Other points considered are the vagueness of the Sibylline prophecies, which cannot be fixed on any one church of the IXth or Xth century and the phonetic handling of Irish names. If the Irish themselves did not sound final *gh*, why should a Scandinavian poet or scribe, writing by ear introduce a *g*? Professor Hart then discusses Edzardi's and Bartsch's attempts to establish a direct connection between Irish forms of verse and those of non-Keltic races, which essays he considers unsatisfactory. A résumé of Jubainville's strictures on Bartsch's identification of Irish verse with Romance (see Am. Jour. of Phil., I, 1, p. 111) is then given and Jubainville's doctrine emphasized. "Primitive Irish verse must have been made up of words retaining certain terminal syllables of inflexion. We do not possess any such verse; consequently we must first find some before constructing our theory." Edzardi attempts to show that some of the metres used by the Skalds are reproductions of well-known Irish forms of verse, but Edzardi has not the knowledge of Irish necessary to establish this hypothesis which is in itself not impossible, nor even improbable. The article concludes with some characteristics of Irish verse-structure.

Notes.—1. *Varia*, by M. W. HUMPHREYS, on *μέμφομαι*; on Eurip. Alcest., 403; on *ἔα*; on Ar. Ach., 540; on parodies in Aristophanes. 2. By F. G. ALLINSON on *πῖαρ* as an adjective. 3. By A. LODEMAN in reply to S. GARNER on *je ne sache pas*, in the first number of the Am. Jour. of Phil., p. 197.

The *Reviews and Book Notices* contain articles on Heilprin's Historical Poetry of the Hebrews, by C. H. TOY; on Roby's Latin Grammar, and Weinkauff's Tacitus' Dialogus, by MINTON WARREN; on Braune's Gotische Grammatik, by H. C. G. BRANDT; on G. Meyer's Griechische Grammatik; on Butcher's and Lang's Translation of the Odyssey; on Merriam's Phaeacians, and on Dunbar's Concordance to the Odyssey by the EDITOR.

Reports are given of Mnemosyne, Hermes, Archaeologische Zeitung, Anglia, Zeitschrift der deutschen Morgenländischen Gesellschaft, Alemannia, Paul und Braune's Beiträge, Romania.

Lanx Satura discusses *persuadere aliquem* and other minor matters.

The *Necrology* contains notices of the death of Professor Haldeman and of Professor Anderson.

A full *Index* to Vol. I completes the number.

PROCEEDINGS OF UNIVERSITY SOCIETIES.

Abstracts of the More Important Papers Read at Recent Meetings.

Scientific Association.

December meeting.

The relation between Embryology and Phylogeny, as shown by the development of the Crustacea, by W. K. Brooks.

Descriptive Embryology like descriptive Anatomy cannot give us much insight into the affinities of animals.

The facts of Anatomy must be submitted to a process of comparison and analysis before we can tell what is of taxonomic importance, and what is due to secondary modifications, and the same thing is true of Embryology. Before we can infer relationship from Embryology, we must submit the facts to a process of comparison and analysis in order to sift out what is ancestral from what is due to recent adaptation, and the facts of Crustacean development are of such a character that they furnish an unusually good basis for this sort of analysis.

On the Properties of Numbers called Repetents, by O. H. Mitchell.

An abstract of this paper is given in the University Circular for December, 1880, page 85.

Description of the New Spectroscope, by C. S. Hastings.

Philological Association.

December meeting.

Shakespeare in the Opinion of the Seventeenth Century, by B. C. Burt.

The compilation by Dr. Ingleby and Miss Smith (entitled *Shakespeare's Centurie of Prayse* and published by the New Shakespeare Society in 1879) shows that Shakespeare was favorably regarded during the period 1591-1693, which Dr. Ingleby calls the 'precritical period' of opinions concerning him. But there was considerable dispraise and very much of the praise was indiscriminate. Shakespeare was esteemed principally as an amorous poet, and as a comedian to be classed with Terence. His glory steadily waned from his death to the close of the century, when a number of his best plays had to be very much altered to suit public taste. He received something like due appreciation from a few only. The so-called Baconian theory concerning the authorship of Shakespeare's works receives no support whatever from the study of Seventeenth Century opinion.

Imperfect and Pluperfect Subjunctive in the Roman Folk-Speech, by E. A. Fay.

An abstract of this paper is given on page 95 of this Circular.

Certain Periphrases in Antiphon, by W. J. Alexander.

The periphrases considered were such as may be regarded as resolutions of a verb into the sign of predication (*εἶναι* or *γίγνεσθαι*) and the substantive notion contained in the verb. When these periphrases are employed, the stress is on the substantive notion. In Antiphon the combination most frequently found is that of *εἶναι* or *γίγνεσθαι* with the name of an agent and here the part that the subject takes in the action is emphasized, or in other words, the subject is characterized.

A Note on Sophocles' Antigone, 1102, by C. D. Morris.

καὶ ταῦτ' ἐπαινεῖς καὶ δοκεῖς παρεικαθεῖν; in which the words *καὶ δοκεῖς* are noted by Schneidewin, Nauck, and M. Schmidt as corrupt and unintelligible, while G. Wolff gets rid of the supposed difficulty of making *παρεικαθεῖν* depend on *δοκεῖς* in the sense of 'I must give way,' by construing *ἐπαινεῖς παρεικαθεῖν ταῦτα*, leaving *καὶ δοκεῖς* to stand *διὰ μέσου*. On the assumption, which seemed very doubtful, that the text is not right as it stands, various conjectural emendations were suggested; of these *κεὐλογεῖς* was offered as not departing very widely from the lines of the MSS.; and *μαντικῇ* as suiting the sense excellently, if one should assume the license, so freely resorted to by some editors, of seeking only for an appropriate word, without regard to the traditional lines.

Historical and Political Science Association.

December meeting.

On State Repudiation, by H. C. Adams.

The questions involved in a study of State Repudiation are questions of policy and law. That the credit of every State is bound up in that of each, appears from the necessarily close relation existing between all as members of a Union, amenable to the same laws. Though the States have a legal right to repudiate, this right is a source of weakness rather than of strength. They are now inferior, as industrial and monetary units, to private corporations, which are not sovereign in matters of contract. By surrendering their historic sovereignty, the States would gain actual power, through their increased command over that great instrument of power in this century, money. That there is a necessary and legitimate future for the States as political unities also, must be recognized; for the tendency toward centralization is too rapid to be perfectly healthy. The political power of the States must be regained, while industrial power must be acquired, at least potentially, if they would provide protection to their citizens against the central government on the one hand, and corporations on the other. This can never be accomplished unless the States surrender, or be deprived of, the right to repudiate.

The ability of the States to refuse payment rests upon the Eleventh Amendment to the Constitution, which declares that no State shall be forced to appear before the Supreme Court as defendant, in a suit instituted by a private person. The legal difficulty appears to be one of procedure only. Could the question be presented to the Supreme Court, a State law providing for repudiation must be recognized as unconstitutional, (Murray *v.* Charlestown), but there is no constitutional method of pronouncing judgment upon this unconstitutional act. The laws of certain States have attempted to obviate this difficulty. Thus in New York there is a law whereby a citizen of that State, holding bonds of a delinquent State, may assign them to the attorney-general, who shall, in the name of the State, enter suit in the Federal Courts for recovery. It is not probable that this law will be recognized as constitutional. It is but an evasion of the Eleventh Amendment, and destroys its entire force. Moreover, if the Court should give judgment in favor of plaintiff, it could scarcely be executed; for public property cannot be touched to satisfy public creditors, even though they have judgment against it; private property can only be appropriated to such an object through taxation; while the power of taxation is legislative and cannot be exercised otherwise than under legislative authority. Some more direct and comprehensive method must be adopted before States can be deprived of their right of repudiation.

The Legal Status of Anatomical Science, by E. M. Hartwell.

It was the aim of this paper to institute a comparison between European and American legislation touching human dissection, for the purpose of showing that in the attitude of the different States of the Union one can recognize all the principal stages which have marked the development of Anatomy in Europe from a secret, impious and perilous pursuit to the dignity of a legally protected and fostered science. The basis for this comparison was found in the results of a collation of all the accessible American, English, French and German laws regarding dissection and the violation of sepulture. The history of Anatomy was almost a blank, from the decay of the Alexandrian School of Anatomy, which followed hard upon the death of Ptolemy Soter, who had founded it 300 B. C., till 1315 A. D., when Mondino, an Italian professor, made the first public dissections in Europe. The edict of Pope Boniface VIII., in 1299, against the boiling, drying, or cutting up of dead bodies was an obstacle to the pursuit of Anatomy till 1556; although Pope Sixtus IV., in 1482, granted the University of Tübingen the privilege of dissecting executed criminals. In 1556, the Divines of Salamanca, out of regard for the Emperor Charles V., who was the patron of Vesalius the father of modern Anatomy, declared that human dissections were allowable. The rise of Anatomy in Italy, France, Germany and especially Great Britain was considered. The action of the Town Council of Edinburgh, in 1505, in granting a dead criminal yearly to the Surgeons was noted, and also that of Henry VIII., in 1540, in giving the Barber Surgeons of London, the right to dissect four felons' bodies annually. The further course of English legislation was traced; and the circumstances which led to the great amount of grave-robbery in Great Britain in the early part of this century, were considered. Some account was given of the Burking horrors of Edinburgh, in 1828, which led to the passage, in 1832, of the Warburton Anatomy Act, which is still in force.

It was shown that the Massachusetts law of 1692, against witchcraft, was the first American statute forbidding grave-robbery; and that the principal American medical schools had developed from private courses of anatomical lectures given in defiance of popular prejudice and without legal warrant. The history of the Massachusetts Anatomy Act of 1831, the first in America, was fully discussed. A summarized statement of American legislation from 1784 till 1880, was given, showing what States have legalized dissection; what States have liberal anatomy laws; and what States have illiberal laws or none at all. The position of the District of Columbia among the capitals of civilized States was characterized as unique, in that the studies of its anatomists and the graves of its dead are alike unprotected by statutory enactments. It was shown by statistics, gathered by the writer from teachers of anatomy, that a large proportion of medical students were entirely unprotected by law in their preliminary and absolutely essential studies; and that the scarcity and high cost of anatomical material in America, made it necessary for those desiring to learn thoroughly all branches of human anatomy to repair to the anatomical schools of Europe. The necessity of passing a law in Maryland to prevent the violation of graves and to legalize dissection in certain cases was strongly insisted upon. In conclusion it was stated that while an Act which should embody the best provisions of the best American Acts would compare favorably with the present British laws, it would fall far short, in point of fulness and liberality, of the laws of France of seventy-five years ago; not to speak of the French and German laws of to-day.

List of Baltimore Newspapers, contributed, through the Secretary, by JOHN W. M. LEE.

The following files of Baltimore newspapers are preserved in the library of the Maryland Historical Society, and have been carefully collated by Mr. Lee, the librarian. These files have been found most important sources of local, state, and national history. The first paper on the list is the *Maryland Journal and Baltimore Advertiser*, in which George Washington advertised for sale twenty thousand acres of western land. This paper, which covers the Revolutionary period, is now said to live in the *Baltimore American and Commercial Advertiser*. The Washington correspondence of some of these old papers, like the *Baltimore Patriot*, is in some respects a better source of information than the *National Intelligencer* and other Washington Journals, before 1850. The files of *The Sun* and other Baltimore papers are now being rapidly filled up by gift and purchase. There are already several valuable foreign newspapers to be found in the collections of the above Society, for example, the *Moniteur*, covering the period of the French Revolution. A complete list of journals published elsewhere than in Baltimore and preserved here, is now in preparation by Mr. Lee.

The Maryland Journal and Baltimore Advertiser. 1773–1797.
Dunlap's Maryland Gazette, or the Baltimore General Advertiser. 1775–1779. Continued as The Maryland Gazette.
The Maryland Gazette. 1783–1791.
The Baltimore Daily Repository. 1791–1793.
Baltimore Daily Intelligencer. 1793–1794. Continued as Federal Intelligencer and Baltimore Daily Gazette.
Federal Intelligencer and Baltimore Daily Gazette. 1795. Continued as Federal Gazette.
Federal Gazette. 1796–1825. Continued as The Baltimore Gazette.
The Baltimore Gazette. 1825–1837.
The Telegraph and Daily Advertiser. 1797–1802.
American and Daily Advertiser—American and Commercial Advertiser. 1799–1801, 1804, 1806, 1808–1811, 1813–1824, 1827, 1829–1842, 1845–1880.
The Republican, or Anti-Democrat. 1802–1803.
The American Patriot and Fells Point Advertiser. 1802–1803.
Baltimore Evening Post. 1805–1811.
The Whig. 1808–1810. Continued as The Baltimore Whig.
The Baltimore Whig. 1810–1811.
North American and Mercantile Advertiser. 1808–1809. Continued as Federal Republican and Commercial Gazette.
Federal Republican and Commercial Gazette. 1809–1811.
The Baltimore Patriot. 1812–1847.
The Mechanics' Gazette and Merchants' Daily Advertiser. 1815.
The Peoples' Friend. 1816.
Federal Republican and Baltimore Telegraph. 1819, 1823.
Morning Chronicle and Baltimore Advertiser. 1820–1823.
North American. 1827.
The Marylander. 1827–1828.
Baltimore Republican. 1829–1863.
Baltimore Weekly Gazette. 1832–1834.
The Daily Chronicle. 1833.
Baltimore Daily Transcript—Baltimore Commercial Transcript. 1836–1838.
Commercial Chronicle and Daily Marylander. 1839.
Baltimore Clipper. 1839–1840.
Spirit of Democracy. 1840.
The Sun. 1841–1843, 1859–1872.
The Weekly Argus. 1849–1851. Weekly edition of Baltimore Republican.
The Daily Exchange. 1859–1861. Continued as The Maryland Times.
The Maryland Times—The Maryland News-sheet. 1861–1862. For continuation see Baltimore Daily Gazette.
Baltimore Daily Gazette. 1862–1869, 1873–1880.
The South. T. W. Hall, Jr. 1861.
The South. J. M. Mills & Co 1861–1862.
Evening Bulletin. 1876–1879.
The Telegram. 1879–1880.

Mathematical Seminary.

December meeting.

On the Similarity between Congruences and Equations, and its Significance, by ARTHUR S. HATHAWAY.

The operations of addition, subtraction, multiplication and involution, are the same for congruences as for equations. To this list may be added the operation of division by defining $\frac{b}{a}$ as a solution of $ax \equiv b$. The value of $\frac{b}{a}$ may be obtained by substituting for b, a congruous number which is divisible by a. The operation of a^{-1}, if $a \equiv 0$, is excluded from congruences, in analogy with the exclusion of 0^{-1} from equations. The operation a^{-1} leads to impossible or indeterminate results also, if $a \equiv 0$ with respect to any divisor of the modulus. These fractional forms obey the ordinary laws of combination, thus: $\frac{b}{a} + \frac{d}{c} \equiv \frac{bc + ad}{ac}$, $\frac{b}{a} \times \frac{d}{c} \equiv \frac{bd}{ac}$, &c. To include in the above list the operation of evolution, we define $\sqrt[n]{b}$ as a solution of $x^n \equiv b$. Radical forms combine as ordinarily, thus: $\sqrt[m]{\sqrt[n]{b}} \equiv \sqrt[mn]{b}$, $\sqrt[n]{a}\,\sqrt[n]{b} \equiv \sqrt[n]{ab}$, &c. In general, to include the operation f^{-1} in the above list, we define $f^{-1}(b)$ as a solution of $f(x) \equiv b$. If k be the modulus, the substitution of $b + \lambda k$ for b cannot be said to alter the *identity* of $f^{-1}(b)$ since it does not alter the congruence $f(x) \equiv b$. If an integer a satisfy this congruence, we have $f(a) = b + \lambda k$ and therefore $a = f^{-1}(b + \lambda k)$. If there is no integral solution of $f(x) \equiv b$, $f^{-1}(b)$ is not integral for any variation of the parameter b by integral multiples of the modulus, and I shall call it *imaginary*. It may be adopted, as a convention, that $kf^{-1}(b) \equiv o \bmod k$. Then if $f(x) \equiv b \pmod{k}$ has, in this extended sense, *any* solution (a) real or imaginary, we must have $f(a) = b + \lambda k$, where λ is some real or imaginary quantity. Therefore $a\ [= f^{-1}(b + \lambda k)]$ is included in the solution $f^{-1}(b)$. When the modulus is a prime, it can be shown that every congruence has as many roots, real and imaginary together, as its degree, and no more.

Thus, where the modulus is a prime, the correspondence between congruences and equations is perfect. The significance of this is that nearly every proposition in the Theory of Equations is also a proposition in the Theory of Numbers. For example, (1) The relations between the roots and the coefficients of $f(x) \equiv 0$ are the same as in the case of equations. (2) If the resultant of two equations is congruous to zero, the equations, regarded as congruences, have a common rational factor with respect to the modulus. (3) If the discriminant of an equation is congruous to zero, the equation, regarded as a congruence, has equal roots, &c., &c.

A new proof of Euler's development of the infinite product $(1 - x)(1 - x^2)(1 - x^3)$ . . . . . . By FABIAN FRANKLIN.

The coefficient of x^n in the development is evidently the number of ways in which n can be made up of an even number of unrepeated integers, *minus* the number of ways in which it can be made up of an odd number of unrepeated integers. In this proof it is shown that to every one of the even partitions there corresponds an odd partition, and *vice versa*; unless n is of the form $\frac{3k^2 \pm k}{2}$, in which case there is one partition consisting of k parts which has no mate. Hence the above infinite product is equal to $\Sigma(-)^k x^{\frac{3k^2 \pm k}{2}}$; *i. e* to

$$1 - x - x^2 + x^5 + x^7 - x^{12} - x^{15} + x^{22} + x^{26} - \ldots\ldots$$

Euler obtained the development of the product by a peculiar arrangement and treatment of the work of multiplication.

A Theorem including Fermat's and Wilson's Theorems, by O. H. MITCHELL.

If g be any primitive root of the modulus a^t, a being an odd prime, δ any divisor of $\tau(a^t)$, and $x', x'', \ldots, x^{\left[\frac{\tau(a^t)}{\delta}\right]}$, be roots of $x^\delta \equiv g^\delta$, $x^\delta \equiv g^{2\delta}, \ldots, x^\delta \equiv g^{\tau(a^t)}$, respectively, then by multiplication, we have,

$$\left(x'\ x''\ \ldots\ x^{\left[\frac{\tau(a^t)}{\delta}\right]}\right)^\delta \equiv \left(-1\right)^{\frac{\tau(a^t)}{\delta}+1} \text{ mod. } a^t.$$

This becomes Fermat's Theorem, for $\delta = \tau(a^t)$, and Wilson's Theorem, for $\delta = 1$.

This is another form of the theorem given by Gauss, [D. A., § 75], from which he deduces Wilson's Theorem as a special case.

The corresponding general theorem, for $k =$ any integer, is

$$\left(X'\ X''\ \ldots\ X^{\left[\frac{\tau_s(k)}{\Delta}\right]}\right)^\Delta \equiv R_s \text{ mod. } k;$$

except when $\frac{k}{\sigma} =$ the power of an odd prime number, double such a power, or $= 4$, and $\frac{\sigma}{s}$ is at the same time an odd number, in which cases,

$$\left(X'\ X''\ \ldots\ X^{\left[\frac{\tau_s(k)}{\Delta}\right]}\right)^\Delta \equiv \left(-R_s\right)^{Q+1} \text{ mod. } k,$$

where $\Delta =$ any divisor of $\tau\left(\frac{k}{\sigma}\right)$ and $Q =$ the number of nth residues mod. $\frac{k}{\sigma}$.

For the meaning of $\tau(k)$, $\tau_s(k)$, S and σ, see the report of the Mathematical Seminary in the University Circular for May, 1880, page 67. A fuller statement and a proof of the general theorem will appear in the *American Journal of Mathematics*.

SEMI-ANNUAL EXAMINATIONS.

Official Announcement.

As an experiment, the Academic council has decided that the semi-annual examination in the mid-winter of 1881, be held upon the following plan.

The several Instructors will decide at what time it is desirable that their classes should be examined in a particular part of a subject or book; and on giving notice to the President, they may have this examination set down for the first available day.

Persons who are examined will understand, that the fact that an examination in a particular subject is to be held, will in no case be regarded as an excuse for want of attention to other studies.

It was at first proposed to hold the examinations on Saturdays, exclusively, but this feature of the plan has been, on re-consideration, given up.

By vote of the Academic Council.

January 6, 1881.

THE TYNDALL TRUST FOR THE PROMOTION OF SCIENCE.

Edwin H. Hall, Ph. D., Assistant in the Physical Laboratory, has been invited to one of the Scholarships established by Professor John Tyndall.

It may be interesting in this connection to reproduce the deed of foundation of the Tyndall Trust, which bears date February 7, 1873, and is, in substance, as follows: —

> "I, John Tyndall, Professor of Natural Philosophy in the Royal Institution of Great Britain, having, at the solicitation of my friends, lectured in various cities of the United States, find the receipts and disbursements on account of these lectures to be as follows: * * * * * making the net proceeds of the lectures, $13,033 34.
>
> "As an evidence of my good will toward the people of the United States, I desire to devote this sum of thirteen thousand and thirty-three dollars to the advancement of theoretic science and the promotion of original research, especially in the department of Physics, in the United States. To accomplish this object, I hereby appoint Professor Joseph Henry, Secretary of the Smithsonian Institution, Washington, D. C., Dr. E. L. Youmans, of New York, and General Hector Tyndale, of Philadelphia, to act as a board of trustees to take charge of the above sum, to carefully invest it in permanent securities; and I further direct that the said board shall, for the present, appropriate the interest of the fund in supporting or in assisting to support at such European Universities as they may consider most desirable, two American pupils, who may evince decided talents in physics, and who may express a determination to devote their lives to this work. My desire would be that each pupil should spend four years at a German university—three of those years to be devoted to the acquisition of knowledge and the fourth to original investigation.
>
> "If however in the progress of science in the United States, it should at any time appear to the said board that the end herein proposed would be better subserved by granting aid to students, or for some special researches in this country, the board is authorized to make the appropriations from the income of the fund for such purpose." * * * * .

The deed of trust and correspondence connected therewith is given in full in the Report of the Smithsonian Institution for 1872, p. 104, etc.

The present Trustees of the Tyndall Fund are Professor E. L. Youmans, President F. A. P. Barnard, and Professor J. Lovering.

GIFT TO THE LIBRARY.

Henry Holt, Esq., of New York, has generously presented to the University a series of his publications issued since his former gift of a like character. The recent list includes the following valuable works:

Baker, H. B., *English Actors*, 2 vols.—Baker, J., *Turkey.*—Beerbohm, J., *Wanderings in Patagonia.*—Beers, H. A., *Century of American Literature.*—Berlioz, H., *Selections from Writings.*—Bessey, C. E., *Botany.*—Brassey, Mrs., *Around the World; Sunshine and Storm in the East.*—Conway, M. D., *Demonology.*—Cory, W., *Guide to Modern English History, Vol. I.*—Creasy, E. S., *Ottoman Turks.*—*Democracy; an American Novel.*—Dobson, A., *Vignettes.*—Escott, J. H. S., *England.*—Fothergill, J., *The First Violin.*—Goodholme, J. S., *Domestic Cyclopædia.*—Grohman, W. A. B., *Gaddings with a Primitive People.*—Hardy, T., *The Trumpet-major.*—Hillebrand, K., *German Thought.*—Jackson, Lady C. C., *Old Paris.*—James, H. A., *Communism in America.*—Janvier, C. A., *Keramics.*—Johnson, R., *Famous Poems.*—Johnston, A., *American Politics.*—Kemble, Frances A., *Records of a Girlhood.*—Lewes, G. H., *Actors and Acting.*—McCoan, J. C., *Egypt.*—Morgan, L. H., *Ancient Society.*—Newcomb and Holden, *Astronomy.*—Packard, A. S., *Zoölogy.*—Rydberg, V., *Magic of the Middle Ages.*—Symonds, J. A., *Renaissance.*—Taine, H. A., *French Revolution. Vol. I.*—Thornbury W., *Life of Turner.*—Turgenieff, I., *Virgin Soil.*—Tylor, E. B., *Early History Mankind.*—Walker, F. A., *Money.*—Wright, C., *Philosophical Discussions.*

LECTURES ON THE HISTORY OF PHILOSOPHY.

By Professor George S. Morris.

A. ***Public Lectures.*** Six Lectures on the History of Philosophy in Germany from Leibnitz to Hegel. (See p. 99 of this Circular.)

B. ***Courses for University Students.*** Three Lectures weekly on the History of German Philosophy, beginning the first week in January, 1881. Undergraduate students, (previously instructed in Logic and Psychology), who may follow these lectures with a view to the completion of a Minor Course, will be advised respecting the choice of a special subject for collateral study and examination.

The lecturer will, as heretofore, hold himself in readiness, as far as possible, to direct and assist students, individually or in classes, in the study or investigation of special topics.

The forthcoming numbers of the American Journal of Mathematics will contain, among others, the following articles:

A Method of Developing the Perturbative Function of Planetary Motion, by Simon Newcomb.

On De Morgan's Extension of the Algebraic Processes, by Miss Christine Ladd.

On the Motion of a Perfect Incompressible Fluid when no Solid Bodies are Present, by Henry A. Rowland.

On Certain Possible Cases of Steady Motion in a Viscous Fluid, by Thomas Craig.

On Binomial Congruences: Comprising an Extension of Fermat's and Wilson's Theorems and a Theorem of which Both are Special Cases, by O. H. Mitchell.

On the Ratio between Sector and Triangle in the Orbit of a Celestial Body, by Ormond Stone.

Center of Gravity of Surface and Solid of Revolution, by E. W. Hyde.

Linkages for x^m, by Frank T. Freeland.

The Strophoids, by W. W. Johnson.

The next number of the American Chemical Journal, (Vol. II, No. 6), now in press, will contain papers as follows:

On an Apparatus for Determining Specific Heat, by J. W. Mallet.

Two mineralogical papers, by G. A. König.

On the Synthesis of Anthracene, by C. Loring Jackson and J. Fleming White.

The Estimation of Sulphur in Illuminating Gas, by W. G. Mixter.

Also papers by M. Kuhara, R. D. Coale and the Editor; and *Reports* by J. W. Mallet and H. P. Armsby.

The American Journal of Science (January, 1881) contains a paper by Charles S. Hastings, Ph. D., Associate in Physics, on *A Theory of the Constitution of the Sun founded upon spectroscopic observations, original and other.* 12 pp. 8°.

The number of the same journal for December, 1880, has a paper by E. B. Wilson, Fellow in Physics, on *The Early Stages of Renilla.* 4 pp. 8°; 1 plate.

The New Englander (January, 1881) contains a paper by Henry C. Adams, Ph. D., on *The Irish Land Question.* 19 pp., 8°.

The London, Dublin and Edinburgh Philosophical Magazine (November and December, 1880) contains papers by E. H. Hall, Ph. D., Assistant in Physics, on *The New Action of Magnetism on a Permanent Electric Current*, 29 pp., 8°; by Thomas Craig, Ph. D., Associate in Mathematics, on *Steady Motion in an Incompressible Viscous Fluid*, 16 pp., 8°; by L. B. Fletcher, A. M., Graduate Student of Physics, *Note on the Relation between the Mechanical Equivalent of Heat and the Ohm.*

Candidates for the graduate scholarships must submit to the President, on or before January 12, 1881, any written papers which they wish to have considered.

HOPKINS HALL LECTURES AT 5 P. M.

Lectures by the Scientific Professors,

AT THE SPECIAL REQUEST OF THE TRUSTEES.

1. **PROFESSOR J. J. SYLVESTER.**

Friday, January 7. The Laws of Verse.

2. **PROFESSOR IRA REMSEN.** Four lectures on Selected Topics in Chemistry.

1. *Monday, January* 10. The Discovery of the Composition of Water.
2. *Tuesday, January* 11. Drinking Waters; with reference to the Water of Baltimore.
3. *Thursday, January* 13. Pure and Impure Air.
4. *Friday, January* 14. Illuminating Gas: its Manufacture.

3. **PROFESSOR H. NEWELL MARTIN.** Four lectures on The Living Human Body, as viewed from the Standpoint of General Biology.

1. *Monday, January* 17. The Fundamental Physiological Actions.
2. *Tuesday, January* 18. The Physiological Division of Employments.
3. *Thursday, January* 20. The Nervous System.
4. *Friday, January* 21. The Blood and its Flow.

4. **DR. CHARLES S. HASTINGS.** Four lectures on Light.

1. *Monday, January* 24. The Eye as an Optical Instrument.
2. *Tuesday, January* 25. Light Produced by a Wave Motion.
3. *Thursday, January* 27. The Prismatic Spectrum.
4. *Friday, January* 28. The Prismatic Spectrum.

5. **PROFESSOR HENRY A. ROWLAND.** Four lectures on The Conservation of Energy.

1. *Monday, January* 31.
2. *Tuesday, February* 1.
3. *Thursday, February* 3.
4. *Friday, February* 4.

Lectures on Literary and Historical Subjects.

6. **MR. SIDNEY LANIER.** Twelve lectures, Wednesday, January 12, 19, 26; February 2, 9, 16, 23; March, 2, 9, 16, 23, and Saturday, March 26.

Subject: "From Aeschylus to George Eliot: Twelve Studies in the Modern English Novel as a Development of the Greek Drama.

The main lines of treatment will be as follows:

(1) The *Prometheus* of Aeschylus, the *Prometheus* of Shelley, and the *Deukalion* of Bayard Taylor will be compared as to their unconscious utterances of the great underlying ideas of their respective times; and from these, with other considerations, will be traced those characteristic features of our own civilization which have determined the novel as the only literary form adequate to their expression.

(2) Some readings from *Hamlet* will be offered, as showing a transition-stage between the Greek drama and the modern novel: in the Shaksperean drama the Greek Chorus has practically disappeared, while in the novel the Chorus is practically revived and brought to its greatest efficiency, in the running comment and description of the author.

(3) The precise significance of the novel-form being fixed, its application to the complexities of modern existence will be illustrated in special studies of George Eliot's *Daniel Deronda*, James's *The American*, Howells's *The Undiscovered Country*, Cable's *The Grandissimes*, Collins's *The Moonstone*, and other characteristic fiction of the time.

(4) Finally, the net outcome of English novel-writing will be considered, as possibly a result of the same scientific spirit which has signalized our time in physical research.

7. **MR. ALBERT S. COOK.** Six lectures on Englishmen before the Conquest.

1. *Thursday, February* 17. Our English Forefathers and their Home.
2. *Thursday, February* 24. Beowulf, the oldest Germanic Epic.
3. *Thursday, March* 3. Anglo-Saxon Religious Poetry.
4. *Thursday, March* 10. The Venerable Bede.
5. *Thursday, March* 17. King Alfred.
6. *Thursday, March* 24. The Perpetuation of Anglo-Saxon Influence. Wycliffe.

8. **PROFESSOR GEORGE S. MORRIS.** Six lectures on the History of Philosophy in Germany from Leibnitz to Hegel.

1. *Friday, February* 18. Comparative Biography of Leibnitz, Kant, Fichte, Schelling and Hegel.
2. *Friday, February* 25. The Theory of Knowledge, as developed by these philosophers.
3. *Friday, March* 4. The Theory of Being. (Comparative view of the doctrines of the same philosophers.)
4. *Friday, March* 11. Theory of Nature. (Comparative view.)
5. *Friday, March* 18. Theory of Man. (Comparative view.)
6. *Friday, March* 25. Philosophy in German Literature.

9. **DR. HERBERT B. ADAMS.** Five lectures on The Teutons in Church and State.

1. *Monday, February* 21. The Aryan Migrations.
2. *Monday, February* 28. Rome and the Teutons,
3. *Monday, March* 7. The Spirit of Teutonic Liberty.
4. *Monday, March* 14. The Ancient Faith of the Teutons.
5. *Monday, March* 21. The Church and the Teutons.

10. **PROFESSOR J. LEWIS DIMAN,** of Brown University. Ten lectures on the Theistic Argument, as affected by recent theories.

1. *Monday, March* 28. Present Aspects of the Problem.
2. *Tuesday, March* 29. Cause and Force.
3. *Wednesday, March* 30. The Argument from Order.
4. *Thursday, March* 31. The Argument of Design.
5. *Friday, April* 1. Evolution and Final Cause.
6. *Monday, April* 4. Immanent Finality.
7. *Tuesday, April* 5. Conscience and a Moral Order.
8. *Wednesday, April* 6. History and a Moral Purpose.
9. *Thursday, April* 7. Personality and the Infinite.
10. *Friday, April* 8. The Inferences from Theism.

11. **DR. AUSTIN SCOTT.** Ten lectures on the Development of the American Constitution, beginning April 20.

Dates and Special Topics will be announced later in the season.

Scientific Periodicals Published under the Auspices of the Johns Hopkins University.

I.

AMERICAN JOURNAL OF MATHEMATICS.

Professor J. J. Sylvester, F. R. S., D. C. L., Editor in Chief; W. E. Story, Ph. D., Associate Editor in charge. Quarto. Quarterly. Subscription $5.00 per year.

Vol. i. 1878. 388 pp. 4°. 4 plates.
Vol. ii. 1879. 404 pp. 4°. 3 plates.
Vol. iii. 1880. Three numbers printed.

II.

AMERICAN CHEMICAL JOURNAL.

Professor I. Remsen, M. D., Ph. D., Editor. Octavo. Bi-monthly. Subscription $3.00 per year.

Vol. i. 1879. 460 pp. 8°.
Vol. ii. 1880.
Vol. iii. Begins in 1881.

III.

THE AMERICAN JOURNAL OF PHILOLOGY.

Professor B. L. Gildersleeve, Ph. D., LL. D., Editor. Octavo. Quarterly. Subscription $3.00 per year.

Vol. i. 1880. 520 pp. 8°.
Vol. ii. Begins in 1881.

IV.

STUDIES FROM THE BIOLOGICAL LABORATORY.

Professor H. N. Martin, Dr. Sc., Editor, and W. K. Brooks, Ph. D., Associate Editor. Octavo. Price $3.50 per volume.

Vol. i. 1879–80. 500 pp. 8°. 40 plates.
Vol. ii. 1881. In preparation.

This includes contributions from the University to various Biological journals, and also the papers independently printed as the "Results of the Chesapeake Zoölogical Laboratory."

V.

THE JOURNAL OF PHYSIOLOGY.

Michael Foster, M. D., F. R. S., Cambridge, England, Editor in Chief. Octavo. Six parts will form a volume of about 500 pp. Subscription $5.00 per volume.

Vol. i. 1878–79. 626 pp. 8°. 17 plates.
Vol. ii. 1879–80. 596 pp. 8°. 13 plates.
Vol. iii. 1880–81, in progress.

This Journal will in future be published in America with the aid of the Johns Hopkins University, and will be issued from the University to subscribers.

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[THIS NUMBER IS ESPECIALLY DEVOTED TO BIOLOGY].

JOHNS HOPKINS UNIVERSITY CIRCULARS.

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CALENDAR.

April 15-18.	**Spring Recess.**
May 2.	**Session of Marine Laboratory at Beaufort Begins.**
June 6-9.	**Examinations for Matriculation.**
June 10.	**Present Term of Instruction Closes.**
September 20.	**Sixth Academic Year Begins.**
September 21-24.	**Examinations for Matriculation.**
September 27.	**Instructions Resumed.**

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MEETINGS OF SOCIETIES.

Scientific. First Wednesday of each month at 8 P. M. Next meeting, April 6.
E. H. Hall, Secretary.

Philological. First Friday of each month, at 12 M. Next meeting, April 8.
M. Warren, Secretary.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, April 12.
Allan Marquand, Secretary.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, March 18.
H. B. Adams, Secretary.

Mathematical. Third Wednesday of each month, at 8 P. M. Next meeting, March 16.
O. H. Mitchell, Secretary.

Naturalists' Field Club. Excursions each Saturday during the Spring and Autumn. Regular meetings for the reading and discussion of papers once a month.
E. M. Hartwell, Secretary.

ACADEMIC STAFF, 1880-81.

Academic Council.

Daniel C. Gilman. President of the University.
A. B., Yale College, 1852, and A. M., 1855; LL. D., Harvard University and St. John's College, 1876; Professor in Yale College, 1863-72; President of the University of California, 1872-75.

Basil L. Gildersleeve. *Professor of Greek.*
A. B., Princeton College, 1849, and A. M., 1852; Ph. D., University of Göttingen, 1853; LL. D., College of William and Mary, 1869; Professor of Greek in the University of Virginia, 1856-76; Professor of Latin in the University of Virginia, 1861-66.

H. Newell Martin. *Professor of Biology.*
M. B., University of London, 1871, and Dr. Sc., 1872; A. B., University of Cambridge, 1874, and A. M., 1877; Fellow, and late Lecturer on Natural History in Christ College, Cambridge; Fellow of University College, London.

Charles D. Morris. (*Collegiate*) *Professor of Latin and Greek.*
A. B., Lincoln College, Oxford, 1849, A. M., and Fellow of Oriel College, Oxford, 1852; Professor in the University of New York, 1875-76.

Ira Remsen. *Professor of Chemistry.*
College of the City of New York; M. D., College of Physicians and Surgeons, N. Y., 1867; Ph. D., University of Göttingen, 1870; Professor of Chemistry in Williams College, 1872-76, and previously Assistant in Chemistry in the University of Tübingen.

Henry A. Rowland. *Professor of Physics.*
C. E., Rensselaer Polytechnic Institute, Troy, 1870; Assistant Professor in the same, 1872-75; Ph. D., Johns Hopkins University, 1880.

J. J. Sylvester. *Professor of Mathematics.*
A. M., University of Cambridge; F. R. S., London and Edinburgh; Corresponding Member, Institute of France; Member, Academy of Sciences in Berlin, Göttingen, Naples, Milan, St. Petersburg, etc.; LL. D., University of Dublin, University of Edinburgh; D. C. L., University of Oxford; Honorary Fellow of St. John's College, Cambridge; late Professor of Mathematics in the Royal Military Academy, Woolwich.

Lecturers, 1880-81.

A. Graham Bell. *Phonology.*
Ph. D., National Deaf Mute College, 1880.

S. P. Langley. *Physics.*
Director of the Astronomical Observatory, Allegheny, Pa.

Sidney Lanier. *English Literature.*

George S. Morris, *History of Philosophy.*
A. B., Dartmouth College, 1861, and A. M., 1864; late Professor in the University of Michigan.

Charles S. Peirce. *Logic.*
A. B., Harvard University, 1859, A. M., and S. B., 1863; of the U. S. Coast and Geodetic Survey.

Léonce Rabillon. *French Literature.*
Bach. ès Lettres, Université de France, 1832, and Licencié en Droit, 1836.

Associates.

Herbert B. Adams. *History.*
A. B., Amherst College, 1872; Ph. D., University of Heidelberg, 1876; Lecturer on History at Smith College.

Hermann C. G. Brandt. *German.*
A. B., Hamilton College, 1872, and A. M., 1875; Assistant Professor of Modern Languages in Hamilton College, 1874-76.

William K. Brooks. *Biology.*
A. B., Williams College, 1870; Ph. D., Harvard University, 1875; Director of the Chesapeake Zoölogical Laboratory.

William Hand Browne. *Librarian.*
M. D., University of Maryland, 1850.

Albert S. Cook. *English.*
S. B., Rutgers College, 1872, and S. M., 1875.

Thomas Craig. *Mathematics.*
C. E., Lafayette College, 1875; Ph. D., Johns Hopkins University, 1878; of the U. S. Coast and Geodetic Survey.

John M. Cross. *New Testament Greek.*
A. B., Princeton College, 1867, and A. M., 1870; Tutor of Greek in Princeton College, 1873-76.

A. Marshall Elliott. *Romance Languages.*
A. B., Haverford College, 1866, and A. M., 1878; A. B., Harvard University, 1868.

Charles S. Hastings. *Physics.*
Ph. B., Yale College, 1870, and Ph. D., 1873; Holder of the "Tyndall Scholarship" in Paris, 1875.

Harmon N. Morse. *Chemistry.*
A. B., Amherst College, 1873; Ph. D., University of Göttingen, 1875; Instructor in Chemistry at Amherst College, 1875-76.

Austin Scott. *History.*
A. B., Yale College, 1869; A. M., University of Michigan, 1870; Ph. D., University of Leipsic, 1873; late Instructor in History at the University of Michigan.

Henry Sewall. *Biology.*
S. B., Wesleyan University, 1876; Ph. D., Johns Hopkins University, 1879.

William E. Story. *Mathematics.*
A. B., Harvard University, 1871; Ph. D., University of Leipsic, 1875; Tutor of Mathematics in Harvard University, 1875-76.

Philip R. Uhler. *Natural History.*
Librarian of the Peabody Institute, and President of the Maryland Academy of Sciences.

Minton Warren. *Latin.*
A. B., Tufts College, 1870; Ph. D., University of Strassburg, 1879.

Assistants.

Henry C. Adams. *Political Economy.*
A. B., Iowa College, 1874, and A. M., 1877; Ph. D., Johns Hopkins University, 1878. Lecturer at Cornell University, 1879, and at the University of Michigan, 1881.

Samuel F. Clarke. *Biology.*
Ph. B., Yale College, 1878; Ph. D., Johns Hopkins University, 1879.

Fabian Franklin. *Mathematics.*
Ph. B., Columbian University, 1869; Ph. D., Johns Hopkins University, 1880.

Edwin H. Hall. *Physics.*
A. B., Bowdoin College, 1875; Ph. D., Johns Hopkins University, 1880. Appointed to the "Tyndall Scholarship," 1880.

Philippe B. Marcou. *French.*
A. B., Harvard University, 1876, and A. M., 1879.

William T. Sedgwick. *Biology.*
Ph. B., Yale College, 1877.

George H. Stockbridge. *German and Latin.*
A. B., Bates College, 1872, and A. M., 1875.

Fellows.

Louis Bevier. *Greek.*
A. B., Rutgers College, 1878.

Maurice Bloomfield.* *Philology*
A. M., Furman University, 1877; Fellow of the Johns Hopkins University, 1878-79, and Ph. D., 1879; Student of Philology at the University of Leipsic, 1880-81.

James W. Bright. *Teutonic Languages.*
A. B., Lafayette College, 1877, and A. M., 1880.

Benjamin C. Burt. *Philosophy.*
A. B., University of Michigan, 1878, and A. M., 1879.

R. Dorsey Coale. *Chemistry.*

Samuel C. Derby.* *Latin and History.*
A. B., Harvard University, 1866, and A. M., 1877; Professor in Antioch College, Ohio.

Lawrence B. Fletcher. *Physics.*
A. B., Columbia College, 1877, and A. M., 1880; Fellow of Columbia College, 1877-80.

Spencer H. Freeman. *Physics.*
A. B., University of Rochester, 1875, and A. M., 1878.

Edward M. Hartwell. *Biology.*
A. B., Amherst College, 1873, and A. M., 1876.

Mitsuru Kuhara. *Chemistry.*
S. B., University of Tokio, Japan, 1877.

Allan Marquand.* *Logic and Ethics.*
A. B., Princeton College, 1874; Fellow of the Johns Hopkins University, 1878-80, and Ph. D., 1880.

Oscar H. Mitchell. *Mathematics.*
A. B., Marietta College, 1875, and A. M., 1878.

Kakichi Mitsukuri. *Biology.*
Ph. B., Yale College, 1879.

Edward L. Nichols.* *Physics.*
S. B., Cornell University, 1875; Ph. D., University of Göttingen, 1879; Fellow of the Johns Hopkins University, 1879-80.

George F. Nicolassen. *Greek.*
A. B., University of Virginia, 1879, and A. M., 1880.

Bernard F. O'Connor. *Romance Languages.*
Bach. ès Lettres, Université de France, 1874.

Chase Palmer. *Chemistry.*
A. B., Johns Hopkins University, 1879.

Herbert M. Perry. *Mathematics.*
A. B., Harvard University, 1880.

Robert W. Prentiss. *Mathematics.*
S. B., Rutgers College, 1878.

A. F. Wilhelm Schimper. *Biology.*
Ph. D., University of Strassburg, 1878.

Henry A. Short.* *Greek.*
A. B., Columbia College, 1880; now Fellow of Columbia College.

Edward H. Spieker. *Greek.*
A. B., Johns Hopkins University, 1879.

Morrison I. Swift. *Philosophy.*
A. B., Williams College, 1879.

Charles A. Van Velzer. *Mathematics.*
S. B., Cornell University, 1876.

Edmund B. Wilson. *Biology.*
Ph. B., Yale College, 1878.

* Fellows by courtesy.

INSTRUCTORS AND GRADUATE STUDENTS IN BIOLOGY, 1876–81.

Professors and Instructors in Biology, 1876–81.

H. Newell Martin. *Professor of Biology.*

M. B., University of London, 1871, and Dr. Sc., 1872; A. B., University of Cambridge, 1874, and A M., 1877; Fellow, and late Lecturer on Natural History in Christ College, Cambridge; Fellow of University College, London.

William K. Brooks. *Associate, Assistant Professor of Comparative Anatomy, Director of the Seaside Laboratory.*

A. B., Williams College, 1870; Ph. D., Harvard University, 1875.

Henry Sewall. (*Assistant in Biological Laboratory*, 1876–78.) *Associate, Assistant Professor of Animal Physiology.*

S. B., Wesleyan University, 1876; Ph. D., Johns Hopkins University, 1879.

Samuel F. Clarke. (*Assistant in Biology*, 1879–80.) *Instructor of Elementary Summer School*, 1880–81.

Ph. B., Yale College, 1878; Fellow in Biology, Johns Hopkins University, 1876-79, and Ph. D., 1879.

William T. Councilman. *Assistant in Biology*, 1878–79.

St. John's College; M. D., University of Maryland, 1878.

Christian Sihler. *Assistant in Biology*, 1879–80.

Concordia, 1866; M. D., University of Michigan, 1871; Fellow in Biology, Johns Hopkins University, 1877-79, and Ph. D., 1881.

William T. Sedgwick. *Assistant in Biology*, 1880–81.

Ph. B., Yale College, 1877.

Lecturers in Biology, 1876–81.

William James, M. D., of Harvard University, on "the Senses and the Brain." (1878.)

William G. Farlow, M. D., of Harvard University, on "Vegetable Morphology, etc." (1879.)

Fellows in Biology, 1876–81.

William K. Brooks, Ph. D.

From Cleveland, Ohio; A. B., Williams, 1870; Ph. D., Harvard, 1874; Assistant, Boston Society of Natural History, 1874-5; appointed *Associate in Biology* before entering on the Fellowship. (1876.)

Samuel F. Clarke, Ph. D.

From Geneva, Ill.; Assistant Zoölogist, U. S. Fish Commission, 1874-75; Assistant in Zoölogy in Sheffield Scientific School, 1874-76; Ph B., Yale, 1878; Ph. D., Johns Hopkins, 1879; Assistant in Biological Laboratory, 1879-80; *Instructor of Elementary Summer School*, 1880-81. (1876-79.)

Edward M. Hartwell, A. M.

From Littleton, Mass.; Public Latin School, Boston, Mass., 1869; A. B., Amherst, 1873, and A. M., 1876; Vice Principal of High School, Orange, N. J., 1873-74; Instructor in Public Latin School, Boston, 1874-77; Student in Miami Medical College, Cincinnati, Ohio, 1877-78; Graduate Student of Biology and Chemistry, 1878-79. (1879-81.)

Kakichi Mitsukuri, Ph. B.

From Tokio, Japan; Ph. B., Yale, 1879; Graduate Student of Biology, 1879-80. (1880-81.)

Isaac Ott, M. D.

From Easton, Pa.; M. D., University of Pennsylvania, 1869; Resident Physician in St. Mary's Hospital, Philadelphia, 1870: Lecturer on Experimental Physiology in the University of Pennsylvania, 1876-77; A. M., Lafayette, 1877; *Physician, Easton, Pa.* (1878-79.)

Henry J. Rice, M. S.

From Casenovia, N. Y.; B. S., Cornell, 1876, and M. S., 1880; Student of Biology, University of France, Paris, 1878; Assistant, U. S. Fish Commission, 1879: *Professor of Natural Sciences at Michigan Military Academy, Orchard Lake, Michigan.* (1876-78.)

A. F. Wilhelm Schimper, Ph. D.

From Strassburg, Germany; Gymnasium at Strassburg, 1864-1874; Ph. D., Strassburg, 1878; Assistant and Provisional Director in the Museum of Natural History, Strassburg, 1878-80. (1880-81.)

William T. Sedgwick, Ph. B.

From Farmington, Conn.; Ph. B., Yale, 1877; Student in Yale Medical School, 1877-78; Instructor in Physiological Chemistry and Toxicology in Sheffield Scientific School, 1878-79; *Assistant in Biological Laboratory.* (1879-80.)

Henry Sewall, Ph. D.

From Baltimore; S. B., Wesleyan, 1876; Graduate Student of Biology, and Assistant in Laboratory, 1876-78; Ph. D., Johns Hopkins, 1879; Student of Physiology, at Leipsic, 1879-80; *Associate in Biology.* (1878-79.)

Christian Sihler, M. D., Ph. D.

From Fort Wayne, Ind; Concordia, 1865; M. D, University of Michigan, 1871; Assistant in Biological Laboratory, 1879-80, and Ph. D., Johns Hopkins, 1881; *Physician, Cleveland, Ohio.* (1877-79)

Charles O Whitman, Ph. D.

From Newton Highlands, Mass.; A. B., Bowdoin, 1868, and A. M., 1871; Ph. D., Leipsic, 1878; appointed *Professor of Zoölogy at the University of Tokio, Japan*, before entering on the Fellowship. (1879.)

Edmund Beecher Wilson, Ph. B.

From Geneva, Ill.; Ph. B., Yale, 1878; Assistant in Zoölogy at Yale College, 1877-79. (1879-81)

Graduate Students in Biology, 1876–81.

The following list contains only the names of graduate students who have, while attending the University, given most of their time to biological study or research. Physicians in active practice and merely taking a course of instruction in Histology or Physiology are not included in it, but those who have given a considerable portion of their time to study while with us, or who have carried on researches in the Laboratory are enumerated. The list of advanced students who have studied at the seaside laboratory will be found on p. 111.

Howard E. Ames. (Cornell University; M. D., University of Maryland, 1874.)
Joseph C. Arthur. (S. B., Iowa Agricultural College, 1872, and S. M., 1879.)
William H. Arthur. (M. D., University of Maryland, 1876.)
Isaac E. Atkinson. (M. D., University of Maryland, 1865.)
William D. Booker. (M. D., University of Virginia, 1867.)
William C. Boteler. (M. D., University of Maryland, 1878.)
Samuel F. Clarke. (Ph. B., Yale College, 1878; Fellow in Biology, Johns Hopkins University, 1876–79, and Ph. D., 1879.)
William T. Councilman. (St. John's College; M. D., University of Maryland, 1878.)
A. Kerr Bond. (A. B., Johns Hopkins University, 1880.)
Frank Donaldson. (A. B., Harvard University, 1879.)
Delano S. Fitzgerald. (M. D., University of France, 1880.)
Edward M. Hartwell. (A. B., Amherst College, 1873, and A. M. 1876; Fellow in Biology, Johns Hopkins University, 1879–81.)
Walter B. James. (A. B., Yale College, 1879.)
Edmund A. Jarvis. (A. B., Johns Hopkins University, 1880.)
William Lee. (M. D., University of Maryland, 1864.)
Frank P. McLean. (Ph. C., University of California, 1875.)
Kakichi Mitsukuri. (Ph. B., Yale College, 1879; Fellow in Biology, Johns Hopkins University, 1880–81.)
William A. Moale, Jr. (M. D., University of Maryland, 1879.)
Isaac Ott. (M. D., University of Pennsylvania, 1869; A. M., Lafayette College, 1877; Fellow in Biology, Johns Hopkins University, 1878–79.)
Harry F. Reid. (A. B., Johns Hopkins University, 1880.)
Henry J. Rice. (S. B., Cornell University, 1876; Fellow in Biology, Johns Hopkins University, 1876–78.)
A. F. Wilhelm Schimper. (Ph. D., University of Strassburg, 1878; Fellow in Biology, Johns Hopkins University, 1880–81.)
William T. Sedgwick. (Ph. B., Yale College, 1877; Fellow in Biology, 1879–80.)
Henry Sewall. (S. B., Wesleyan University, 1876; Fellow in Biology, Johns Hopkins University, 1878–79, and Ph. D., 1879.)
Charles C. Shippen. (A. B., Harvard University, 1877; M. D., University of Maryland, 1879.)
Christian Sihler. (Concordia, 1866; M. D., University of Michigan, 1871; Fellow in Biology, Johns Hopkins University, 1877–79.)
Edmund B. Wilson. (Ph. B., Yale College, 1878; Fellow in Biology, Johns Hopkins University, 1879–81.)
Hiram Woods, Jr. (A. B., Princeton College, 1879.)
H. Boyd Wylie. (M. D., College of Physicians and Surgeons, [Baltimore], 1877; M. D., Bellevue Hospital Medical College, [N. Y.], 1878.)

The following Physicians, while not able to give up any large proportion of their time to study, have attended courses of instruction (mainly Animal Physiology or Histology) given in the Biological Department.

Jacob D. Arnold. (A. B., Georgetown College, 1873, and A. M., 1876; M. D., Washington University, [Baltimore], 1876.)
Bolling W. Barton. (M. D., University of Maryland, 1865.)
Thomas R. Brown. (M. D., University of Maryland, 1866.)
T. Barton Brune. (M. D., University of Maryland, 1877.)
John Dickson. (M. D., University of Maryland, 1852.)
Frank D. Gavin. (M. D., University of Maryland, 1874.)
William G. Harrison. (M. D., Bellevue Hospital Medical College, [N. Y.], 1864.)
William C. Jarvis. (M. D., University of Maryland, 1876.)
John G. Jay. (M. D., University of Maryland, 1871.)
Lewis W. Knight. (M. D., University of Maryland, 1866.)
Benjamin F. Leonard. (M. D., University of Maryland, 1876.)
John S. Lewis. (M. D., College of Physicians and Surgeons, [Baltimore], 1879.)
William F. Lockwood. (M. D, University of Virginia, 1875; Demonstrator of Anatomy, College of Physicians and Surgeons, [Baltimore].)
Thomas P. McCormick. (M. D., University of Maryland, 1877.)
J. Edwin Michael. (A. B., Princeton College, 1871, and A. M, 1874; M. D., University of Maryland, 1873, now Professor of Anatomy in the same.)
Robert B. Morrison. (M. D., University of Maryland, 1874.)
William E. Moseley. (M. D., Harvard University, 1874.)
Richard H. Thomas. (M. D., University of Maryland, 1875.)
Guy F. Whiting. (M. D., University of Maryland, 1878.)
James G. Wiltshire. (M. D., University of Maryland, 1869; Demonstrator of Anatomy, College of Physicians and Surgeons, [Baltimore].)

ACADEMIC STAFF, 1880–81.

Academic Council.

an. President of the University.
ollege, 1852, and A. M., 1855; LL. D., Harvard University and St. John's Col-; Professor in Yale College, 1863–72; President of the University of Califor- –75.

ersleeve. *Professor of Greek.*
eton College, 1849, and A. M., 1852; Ph. D., University of Göttingen, 1853; . College of William and Mary, 1869; Professor of Greek in the University of ia, 1856–76; Professor of Latin in the University of Virginia, 1861–66.

artin. *Professor of Biology.*
iversity of London, 1871, and Dr. Sc., 1872; A. B., University of Cambridge, 1874, A. M., 1877; Fellow, and late Lecturer on Natural History in Christ College, bridge; Fellow of University College, London.

Morris. *(Collegiate) Professor of Latin and Greek.*
Lincoln College, Oxford, 1849, A. M., and Fellow of Oriel College, Oxford, 1852; fessor in the University of New York, 1875–76.

n. *Professor of Chemistry.*
e of the City of New York; M. D., College of Physicians and Surgeons, N. Y., 1867; h. D., University of Göttingen, 1870; Professor of Chemistry in Williams College, 872–76, and previously Assistant in Chemistry in the University of Tübingen.

. Rowland. *Professor of Physics.*
., Rensselaer Polytechnic Institute, Troy, 1870; Assistant Professor in the same, 1872–75; Ph. D., Johns Hopkins University, 1880.

vester. *Professor of Mathematics.*
. M., University of Cambridge; F. R. S., London and Edinburgh; Corresponding Member, Institute of France; Member, Academy of Sciences in Berlin, Göttingen, Naples, Milan, St. Petersburg, etc.; LL. D., University of Dublin, University of Edinburgh; D. C. L., University of Oxford; Honorary Fellow of St. John's College, Cambridge; late Professor of Mathematics in the Royal Military Academy, Woolwich.

Lecturers, 1880–81.

raham Bell. *Phonology.*
Ph. D., National Deaf Mute College, 1880.

Langley. *Physics.*
Director of the Astronomical Observatory, Allegheny, Pa.

ney Lanier. *English Literature.*

orge S. Morris, *History of Philosophy.*
A. B., Dartmouth College, 1861, and A. M., 1864; late Professor in the University of Michigan.

arles S. Peirce. *Logic.*
A. B., Harvard University, 1859, A. M., and S. B., 1863; of the U. S. Coast and Geodetic Survey.

nce Rabillon. *French Literature.*
Bach. ès Lettres, Université de France, 1832, and Licencié en Droit, 1836.

Associates.

rbert B. Adams. *History.*
A. B., Amherst College, 1872; Ph. D., University of Heidelberg, 1876; Lecturer on History at Smith College.

rmann C. G. Brandt. *German.*
A. B., Hamilton College, 1872, and A. M., 1875; Assistant Professor of Modern Languages in Hamilton College, 1874–76.

lliam K. Brooks. *Biology.*
A. B., Williams College, 1870; Ph. D., Harvard University, 1875; Director of the Chesapeake Zoölogical Laboratory.

lliam Hand Browne. *Librarian.*
M. D., University of Maryland, 1850.

bert S. Cook. *English.*
S. B., Rutgers College, 1872, and S. M., 1875.

mas Craig. *Mathematics.*
C. E., Lafayette College, 1875; Ph. D., Johns Hopkins University, 1878; of the U. S. Coast and Geodetic Survey.

n M. Cross. *New Testament Greek.*
A. B., Princeton College, 1867, and A. M., 1870; Tutor of Greek in Princeton College, 1873–76.

Marshall Elliott. *Romance Languages.*
A. B., Haverford College, 1866, and A. M., 1878; A. B., Harvard University, 1868.

arles S. Hastings. *Physics.*
Ph. B., Yale College, 1870, and Ph. D., 1873; Holder of the "Tyndall Scholarship" in Paris, 1875.

rmon N. Morse. *Chemistry.*
A. B., Amherst College, 1873; Ph. D., University of Göttingen, 1875; Instructor in Chemistry at Amherst College, 1875–76.

tin Scott. *History.*
A. B., Yale College, 1869; A. M., University of Michigan, 1870; Ph. D., University of Leipsic, 1873; late Instructor in History at the University of Michigan.

ry Sewall. *Biology.*
S. B., Wesleyan University, 1876; Ph. D., Johns Hopkins University, 1879.

lliam E. Story. *Mathematics.*
A. B., Harvard University, 1871; Ph. D., University of Leipsic, 1875; Tutor of Mathematics in Harvard University, 1875–76.

R. Uhler. *Natural History.*
the Peabody Institute, and President of the Maryland Academy of Sciences.

Latin.
of Strassburg, 1879.

Assistants.

Henry C. Adams.
A. B., Iowa College, 1874, and A. M., 1877; Ph. D., Johns Hop turer at Cornell University, 1879, and at the University of

Samuel F. Clarke.
Ph. B., Yale College, 1878; Ph. D., Johns Hopkins University,

Fabian Franklin.
Ph. B., Columbian University, 1869; Ph. D., Johns Hopkins Un

Edwin H. Hall.
A. B., Bowdoin College, 1875; Ph. D., Johns Hopkins Univers "Tyndall Scholarship," 1880.

Philippe B. Marcou.
A. B., Harvard University, 1876, and A. M., 1879.

William T. Sedgwick.
Ph. B., Yale College, 1877.

George H. Stockbridge.
A. B., Bates College, 1872, and A. M., 1875.

Fellows.

Louis Bevier.
A. B., Rutgers College, 1878.

Maurice Bloomfield.*
A. M., Furman University, 1877; Fellow of the Johns Hopk Ph. D., 1879; Student of Philology at the University of I

James W. Bright.
A. B., Lafayette College, 1877, and A. M., 1880.

Benjamin C. Burt.
A. B., University of Michigan, 1875, and A. M., 1879.

R. Dorsey Coale.

Samuel C. Derby.*
A. B., Harvard University, 1866, and A. M., 1877; Professor in

Lawrence B. Fletcher.
A. B., Columbia College, 1877, and A. M., 1880; Fellow of Colu

Spencer H. Freeman.
A. B., University of Rochester, 1875, and A. M., 1878.

Edward M. Hartwell.
A. B., Amherst College, 1873, and A. M., 1876.

Mitsuru Kuhara.
S. B., University of Tokio, Japan, 1877.

Allan Marquand.*
A. B., Princeton College, 1874; Fellow of the Johns Ho Ph. D., 1880.

Oscar H. Mitchell.
A. B., Marietta College, 1875, and A. M., 1878.

Kakichi Mitsukuri.
Ph. B., Yale College, 1879.

Edward L. Nichols.*
S. B., Cornell University, 1875; Ph. D., University of Hopkins University, 1879–80.

George F. Nicolassen.
A. B., University of Virginia, 1879, and A. M., [illegible]

Bernard F. O'Connor.
Bach. ès Lettres, Université de France, [illegible]

Chase Palmer.
A. B., Johns Hopkins University, 1879.

Herbert M. Perry.
A. B., Harvard University, 1880.

Robert W. Prentiss.
S. B., Rutgers College, 1878.

A. F. Wilhelm Schimper.
Ph. D., University of Strassburg, 1878.

Henry A. Short.*
A. B., Columbia College, 1880; now Fello

Edward H. Spieker.
A. B., Johns Hopkins University, 1879.

Morrison I. Swift.
A. B., Williams College, 1879.

Charles A. Van Velzer.
S. B., Cornell University, [illegible]

Edmund B. Wilson.
Ph. B., Yale [illegible]

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* Fell

BIOLOGY, 1876-81.

INTRODUCTORY NOTE.

In the organization of this University, prominence was given to the study of Biology, partly because of its importance as a science, considered by itself, and partly because of its fundamental relations to the science of Medicine. The founder of the University was also the founder of a Hospital, now in process of construction upon a wise and generous plan, and it was his wish, as it is the purpose of his trustees, that the University and the Hospital should coöperate in the promotion of medical and sanitary science. Consequently much thought has been given in the Johns Hopkins University to the subject of medical education, and although the time has not yet come for the appointment of a medical faculty or the announcement of professional courses of study, an effort has been made to give a thorough foundation for such courses by instruction in Physics, Chemistry and Biology, as well as in Mathematics and Language. Under the term Biology it is intended to include Physiology and Morphology, both Animal and Vegetable.

A Professor of Biology, who had won many academic honors and was familiar with the methods employed and the principles recognized in the best laboratories of England and the continent, was appointed in 1876, and requested to organize among us this department of instruction. An Associate Professor was designated soon afterward, to whom the branches of Morphology and Comparative Anatomy were assigned, thus leaving the Professor of Biology freer to direct the general administration of the laboratory and to carry forward instruction and researches in Physiology, in accordance with his personal preferences. Other Assistants have been engaged from time to time, and three of the Fellowships have been regularly allotted to students of Biology.

The following statements which come from the Biological Laboratory are printed for the information of all who are interested in observing the results of our work; and also, particularly, to show to young men and their parents what facilities are offered for laying a suitable foundation for the subsequent study of Medicine. It is also thought that abroad as well as at home the encouragement here given to investigation and publication will be noticed with interest.

D. C. Gilman.

President's Office,
Johns Hopkins University, *March 10, 1881.*

GRADUATE INSTRUCTION AND OPPORTUNITIES FOR RESEARCH.

In organizing the graduate work, in which more than half the students of the department are engaged, several facts had to be taken into consideration; foremost among them being the impossibility of immediately furnishing a complete equipment for the highest study in all the subdivisions of biological science without such a disproportionate expenditure of the funds of the University as would be unjust to other branches of learning. Instead of endeavoring to do everything tolerably well, it was thought better to select a few topics to begin with, and to attempt to afford the very best facilities possible in these, leaving others to be taken up successively as opportunity offered. The choice has been mainly determined, by two considerations (1) by the fact that the founder of the University especially desired it to coöperate with the Johns Hopkins Hospital in advancing medical education and science, and (2) by regard to the general policy of the University, in accordance with which, when a choice is possible between two subjects in which to afford special facilities for the most advanced study and to encourage research, that one is selected in which such facilities are less commonly met with elsewhere in the United States; in this way an attempt is made rather to complement than to rival the work of other institutions giving higher instruction.

UNDERGRADUATE COURSES.

The University allows an undergraduate student to select his plan of study from any one of several schedules which are laid down by the authorities. Among the subjects which he may take up, after studying Physics and Chemistry, is Biology, and this study is recommended to those who are preparing themselves to enter at a later period upon the professional study of Medicine.

When the undergraduate enters the Biological Laboratory, he does not at once begin the study of Botany or Zoölogy, or any subdivision of these, but gives attention during the first year to General Biology—to acquiring a general knowledge of the forms assumed and the properties exhibited by living matter. For this purpose the student commences with the study of unicellular organisms; is next carried on through a series of types selected from the higher Fungi, the cryptogamous, and the flowering plants; and is finally made to examine thoroughly a specimen from each class in the animal kingdom. These types form the texts for lectures and recitations upon general biological laws and the phenomena which they are selected to illustrate; but the main work is done in the Laboratory, so that the instruction has a firm practical basis, and the various technical terms are made intelligible through their illustration by the observations of the student himself. Having formed a good acquaintance with a number of adult forms the student next takes up Embryology, the lectures on which are illustrated by a thorough practical study of the development of the chick, and a less extensive one of the developmental histories of some other animals. During this preliminary course the student also, with the aid of a selected series of skeletons, studies the main facts in Human and Comparative Osteology. After its completion some specialization of study is permitted, and the more advanced a student is the more is this encouraged; in the next year, he may select Animal Physiology with Histology, or Animal Morphology, for more detailed study; and it is hoped that Botany will very soon be added to the list.

This undergraduate course, while primarily designed as a stepping stone for those who intend to become Biologists, is at the same time complete in itself, and believed to be the form of biological instruction best adapted for those who do not expect to become either Botanists, Zoölogists, or Physiologists, but who desire to acquire some knowledge of the methods and ideas of modern Biology, as one of the branches of general culture which they select among the studies leading to the baccalaureate degree.

SPECIFIC STATEMENTS IN RESPECT TO THE SUB-DIVISIONS OF BIOLOGICAL STUDY.

Animal Physiology.

The relations of the University to the Hospital seemed from the first to indicate Animal Physiology as a subject having special claims on us, and this opinion was confirmed by a consideration of the present status of that science in this country. Notwithstanding a small number of brilliant physiological discoveries made in the United States, and the fact that several distinguished physiological investigators are found here, it can hardly be said that America has taken her fair part in contributing to the modern advance of Physiology. The costliness and variety of the accurate instruments required for modern physiological research almost preclude any but a well-endowed institution from obtaining them: hence the majority of medical students, even had they time, have not the opportunity of acquiring that practical knowledge of the methods of physiological inquiry which is so valuable an auxiliary in those therapeutical and pathological researches, which, conducted on the modern experimental method, have added so much in late years to the list of remedial agents at the disposal of the practising physician. Numerous good teachers do, no doubt, give instruction concerning those main facts already acquired which it is essential for the practitioner to know, but it seemed important to introduce a graduate course to train men as specialists in Physiology, so that they might not only be qualified to teach it, but to add to our knowledge of the working of the living body, and to supply new facts for the physician to utilize. While Chemistry has made good its position as a science which, though essential to those who practice medicine, has claim to a place in the circle of sciences apart from that or any other immediate practical application, Physiology has only recently begun to advance into that fortunate position and to be pursued for its own sake, as it now is in many European countries; as yet, in the United States it is but little studied, except in immediate connection with a medical curriculum. Manifold experience has, however, shewed that a science rarely makes important advances when pursued merely as a means to some specific end to which it is made secondary; and as modern advances in the investigation of the action of drugs and in the comprehension of pathological phenomena are more and more arrived at by reasonings based on physiological results and by experiments carried on by physiological methods, the time seems to have arrived when, at least in certain centres, Physiology should be made a subject of independent study.

For the reasons briefly stated above, Animal Physiology has formed one of the subjects for special advanced study selected by the Johns Hopkins University; and of its subdivisions, more attention is given to what is commonly known as "Experimental" than to "Chemical" Physiology, the latter being already fairly well provided for in several colleges. Of Animal Histology the same may be said. Therefore, while arrangements were made to enable any student to verify for himself the main points established in Animal Chemistry and Histology, the chief endeavor has been to provide special facilities in the so-called Experimental Physiology, and the instruments brought together for advanced study and research in that branch of knowledge are believed to be more numerous and to cover a wider ground than those to be found elsewhere in this country. The Laboratory is conveniently arranged for advanced work, the rooms occupied by those engaged in it being shut off from the General Laboratory fitted up for the junior students.

As to the method of selecting instruments the following statements may be of interest. Before the opening of the University the Trustees placed at the disposal of Professor Martin, to whom was entrusted the organization of the biological department, a considerable sum, which was mainly expended in procuring the instruments and appliances essential for the various branches of undergraduate biological work. For instance, a number of microscopes were purchased, so that each student should have one for his own use; also the apparatus necessary to enable every one to repeat for himself, (as he is required to do when pain to an animal is not involved), the more easy physiological experiments, and the apparatus necessary for the demonstration of such fundamental physiological facts as are too difficult for the less advanced students to carry out for themselves. Since that time the Trustees have yearly provided $1,000 for the purchase of new instruments; of these some are selected from those which have been described within the preceding twelve months and seem of value, or which, though older, are of general usefulness in the laboratory: the remainder are purchased for the execution of special investigations, so that, within reasonable limits as to cost, any one engaged in a research can have purchased or constructed for him such instruments as he may require. The collection of apparatus is, therefore, somewhat unique; starting with the general outfit of a physiological laboratory, and growing by the constant addition of the more generally useful instruments for demonstration and class-work, it also contains many pieces of apparatus which were ordered for special ends; and both groups are added to yearly.

A competent mechanic, at work on the premises, constructs some of the new apparatus, and also, which is more important, is always at hand for the immediate repair of any instrument which may get out of order.

Animal Morphology.

Arrangements having been made to afford instruction and the means of research in Animal Physiology, and very special facilities for advanced work in some of its branches, the next question for consideration was what should be done to promote graduate study in Zoölogy and Comparative Anatomy. Here again the best principle to adopt seemed to be, after arranging to give the ordinary undergraduate instruction as well as some of the more essential appliances for advanced work in all branches of Zoölogy, to select for special effort and encouragement the subdivision which should appear to be least commonly or efficiently promoted elsewhere.

Facilities for advanced work in Systematic Zoölogy were already well provided in many educational institutions and also in connection with the National Coast and Territorial Surveys, and the National and State Fish Commissions. Of Comparative Anatomy, so far as adult forms are concerned, almost the same may be said, but, with some well known exceptions, the study of the development of individual animals, considered in connection with problems of general Animal Morphology, has received less attention; although the American Fauna affords many unique opportunities, and it is now generally believed that all scientific systems for the classification of animals and the recognition of homologies in the organs of different species, genera, and classes, must be mainly based on the study of the developmental histories of individuals.

The University has accordingly not undertaken the formation of any extensive museum; such typical specimens are provided as are requisite for the satisfactory instruction of ordinary students of Zoölogy, but there has been no attempt to bring together a vast collection such as specialists in Systematic Zoölogy require for their work. Such collections are found in several other educational [illegible]tres, and, therefore, in accordance with the general principles [illegible] University, were not considered as of primary importance [illegible]hile the fact that the National Collections at Washington [illegible]n easy reach of persons residing in Baltimore should any point needing reference to a large museum arise, made it possible for the present to postpone the founding of a Museum of Natural History. Whether the University will ever undertake this task is a question for future decision. No doubt ready access to an extensive collection is of vast importance to every zoölogist, a museum being to him very much what a great library is to the philologist. We may perhaps hope that what Peabody has done in founding a great reference library in Baltimore, which has freed the University Trustees from the necessity of expending their income for that purpose, may some day be supplemented for the biologists through the endowment by some citizen of a Natural History Museum, the organization of which shall be entrusted to experts, so that, while a source of recreation and instruction to the general public, it shall also be available for scientific work.

After the selection of Comparative Embryology as the subject in which to make a special endeavor to afford opportunities for advanced study and research, the next question which presented itself to the authorities of the University was how best to provide these. A consideration of the results accomplished in the private laboratory maintained by Mr. Alexander Agassiz at Newport, and in the Seaside Laboratories supported by several European states and universities, seemed to indicate as the best thing the foundation of a Marine Laboratory for advanced students; and also to make desirable its location as far south as convenient, since the organized facilities for seaside zoölogical study are at present much greater in the northern than in the southern parts of the Atlantic seaboard. In the summer of 1878 such a laboratory was opened at Fortress Monroe on the western shore of the Chesapeake, Professor Martin being immediately responsible to the Trustees for advising its foundation and for its management in accordance with the general plan of the biological department, though in justice to Dr. Brooks, Associate in Biology, it is incumbent to state that the idea originated with him, that he, as its Director, has had the immediate control of the organization of the Marine Laboratory from the outset, and that to him is almost entirely due the success which has attended it. In 1879, the Marine Laboratory was reöpened at Crisfield, on the eastern shore of the Chesapeake, and later in the season moved to its previous location near Fortress Monroe. In 1880, it was conducted at Beaufort, N. C., and will return there next season.

Seaside Summer Schools for more or less elementary teaching in Zoölogy have for some years been conducted in the United States, and the National Fish Commission has for some time annually afforded valuable opportunities to specialists, but the foundation by a University of a Marine Laboratory for advanced study and research, in connection with which no definite teaching was given but which afforded to qualified workers opportunities for original investigation, had not previously been attempted in this country. The results of the experiment, concerning which some details will be found on a subsequent page, have been very satisfactory. A steam launch, fitted up for dredging purposes, has been purchased, microscopes and other necessary apparatus are provided by the University, and those who can shew that they already possess such knowledge as may be expected to qualify them for advanced study, are received as students on the payment of a small fee.

Every year since the organization of the Marine Laboratory applications for admission to it have been received from persons who, on further investigation, were found to be not fully fitted to occupy a place in a laboratory primarily designed for research and for advanced study. As several Summer Schools for elementary instruction in Marine Zoölogy already existed in the United States no special effort was made to accommodate such candidates. Last summer, however, several of the junior students of the University having expressed a desire to spend some time in study at the seaside, a more elementary marine laboratory was organized under the superintendence of Dr. S. F. Clarke, Assistant in the Biological Laboratory. The place selected was that near Fortress Monroe previously occupied by the laboratory for advanced students, and which was known to afford good opportunities for study; as members of the Johns Hopkins University did not occupy all the accommodation available, several persons from elsewhere were received as students. In future, there is a strong probability that if a sufficient desire for summer teaching in Zoölogy is manifested among the undergraduates of the University, a similar class will be organized, (see p. 112).

Botany.

The next subject taken up with a view to providing opportunities for advanced study will probably be Botany and, if possible, either Comparative Vegetable Morphology or Vegetable Physiology will be selected for special encouragement. Systematic and Structural Botany are already so well provided for elsewhere and attract such a large proportion of American botanists, that their claim is obviously less pressing.

At present undergraduates are taught the fundamental facts of botanical science, and, in connection with a Field Club, have the opportunity to acquire a knowledge of the Flora of the Baltimore district, the specimens collected at each weekly excursion being subsequently examined and described under the direction of one of the instructors. During a part of the academic year 1878–79, Professor Farlow, of Harvard College, gave some advanced botanical instruction.

Libraries.

The main reference library of the biological department, as of all others in the University, is that of the Peabody Institute, within three or four minutes walk. In it are contained complete sets of nearly all the more important biological periodicals and of the proceedings of learned societies, as also other works of reference.

Except in the case of books likely to be frequently required for consultation the University has not attempted to duplicate those found in the Peabody Library; and such biological works as it possesses have been selected on the same principle as the physiological instruments. Those which the majority of students are likely to want frequently are purchased for the general library, and duplicates of those most often needed are either kept in the biological laboratory or are placed there from time to time when the subject they treat of is being studied; for instance, monographs on the various vegetable and animal types which undergraduates study in the course of their first year's work. The more important biological journals, in various languages, are taken regularly by the University, so that an advanced worker has, in a vacant half hour, only to walk a few steps to find the current periodical literature in his own subject. A list of the periodicals accessible to those working in Baltimore is given on p. 114.

Apart from the general University Library there is a special biological collection, consisting partly of the more generally needed works of reference and partly of books, pamphlets, &c., purchased in connection with special researches carried on in the Laboratory; the latter form a large part of the collection, as an effort is made to procure for any one engaged in a particular investigation all publications bearing on his work but not readily obtainable, as graduation theses, occasional publications from various continental laboratories, &c., &c. Like the physiological apparatus, the collection of books pertaining to Biology thus falls into two main groups: those apt to be needed for every day use, and those purchased for some specific end and representing some research, completed, in progress, or contemplated: no work is bought because it seems likely on vague general principles to become some day useful to somebody, but as soon as it is wanted it is if possible obtained.

In this connection, it is a pleasant duty to acknowledge the friendly help of Dr. John S. Billings and the other authorities of the Library of the Army Medical Museum in Washington, who have not only afforded every facility to those who have gone to Washington to consult works in that Library, but have sent to Baltimore, from time to time, out of their unrivalled store of physiological works, any which they possessed and which we have requested a loan of for some special purpose. Through their courtesy many otherwise unattainable treatises have been made available to us for study in the quiet of our own rooms, or for use in the Laboratory.

Publications.

In connection with its recognized duty in promoting research, the University almost necessarily assumed the function of publication, and has accordingly assisted, in one way or another, Journals of Mathematics, Chemistry, and Philology. In the case of Biology a special difficulty has to be met, since a large proportion of biological researches require for satisfactory presentation more or less numerous plates, the cost of which makes their publication comparatively expensive. Physiological articles have hitherto been provided for in the Journal of Physiology, edited by Dr. Michael Foster, F. R. S., of Cambridge, England, and of which Professor Martin is one of the American Associate Editors. The publication of the morphological researches presented more difficulty, as they commonly require a greater number of plates and those often colored and expensive to produce; such articles have accordingly been somewhat scattered, according as editors would agree to take them. The scientific results of the Seaside Laboratory in 1878 were published by subscription of a number of citizens of Baltimore; other morphological papers have appeared in various journals, while others were published by the University in a series of "Studies from the Biological Laboratory," which also contains reprints of some of the articles by members of the University published elsewhere, as well as other biological articles by members of the University not previously presented to the scientific world.

In future, the Journal of Physiology, which is the only periodical in the English language devoted solely to the publication of original physiological research, will be published in America with the aid of the Johns Hopkins University, and be issued from it to subscribers. The "Studies from the Biological Laboratory" will also be continued to secure the publication of articles which would otherwise be delayed, and partly also to bring together in the form of collected reprints the researches yearly proceeding from the Laboratory and scattered in different periodicals.

Special Students.

Under this head may be included a number of persons, some graduates of a college and some not, who have desired to gain a knowledge of certain departments of Biology, without carrying on such prolonged study as is necessary to those who look forward to becoming specialists. The number of medical men, for example, who have entered for a course of instruction in Histology or Animal Physiology has been quite large, and each year several students from medical schools in the city have been admitted to study in the laboratory. In accordance with the general principle of the University, to be chary of its honors but liberal of its benefits, such persons, though not candidates for a degree, are willingly received when circumstances, such as the time which can be given to this work, shew that it is likely to be profitable.

A systematic course of instruction for students who have not matriculated and who do not intend to take the B. A. degree has been thrown open to those who intend hereafter to study Medicine, and who can pass an entrance examination designed to shew whether they have a fair general education. The studies of this course extend through three years; in the second of these the student takes up (with certain other subjects) General Biology, and in the third, Animal Physiology and Histology, and Vertebrate Anatomy. So far at least as Biology is concerned, we believe the facilities thus offered to those who intend to study medicine, and who, for various reasons, are unable to take a full collegiate course such as is requisite for attaining the B. A. degree, are of considerable importance. It practically extends the time occupied in medical studies, and gives the student a sound, if elementary, scientific education as a basis for his technical studies. Physiology in a medical school is, of necessity, nearly always "Human Physiology," which the experience of late years has taught us is as unscientific, studied by itself, as the so-called "Physiological Chemistry." Medical Physiology should be taught on a broader basis of General Physiology, as Medical Chemistry on a previously acquired knowledge of General Chemistry; it is only then that the practical applications of physiological facts, which form the proper field of instruction in a medical school, are likely to be fully appreciated or intelligently retained.

Classes for School Teachers, and Demonstrations to Medical Students.

Efforts have also been made to extend instruction to persons who could not derive immediate benefit from the University work unless special arrangements were devised for them. In 1877, Professor Martin conducted a class for the Instruction in Physiology of School Teachers. The class met on twenty successive Saturdays from 10 A. M. to 2 P. M. Each meeting commenced with a lecture on the topic of the day's work, and the class then adjourned to the Laboratory for practical study. A syllabus of directions for practical work was drawn up and printed, and an attempt was made to give those attending a fair practical acquaintance with Physiological Anatomy and with Histology, and also to show them how to perform such physiological experiments as are suitable for demonstration in schools; a number of other facts in Physiology were demonstrated with the hope of giving a surer basis for intelligent instruction by the members of the class.

In 1878, Dr. Brooks conducted a similar "Teachers' Class" in Zoölogy, the members of which dissected under his supervision a number of typical Invertebrates; a printed syllabus of directions for dissecting the various animals studied was also drawn up for the use of this class.

In 1878–79 and 1879–80, Professor Martin conducted two series of twenty demonstrations in Animal Physiology before a class of students from the medical schools of the city, several physicians also attending; in these all the fundamental physiological experiments were shewn.

Fellowships.

Of the twenty Fellowships of the University, each yielding five hundred dollars annually, and awarded among graduates engaged in advanced study or in research, three are commonly held by biological students. A special announcement on this subject is made by the University.

Societies.

The Scientific Association of the University meets monthly and gives an opportunity for the discussion of recent scientific discoveries, and also for the presentation of results of the researches of members of the University. An abstract of the proceedings of the Association is published in the "University Circulars," which are issued at short intervals during the academic year, and give those engaged in original work an opportunity to secure priority for their discoveries while awaiting an opportunity to publish their researches in more detail.

Periodical biological literature is so extensive that the need of some systematic division of the labor of keeping abreast with it early made itself felt. To assist in this task a Journal Club has been organized, its members being the instructors and graduate students of the biological department of the University. The current journals are parcelled out among the members, who in turn report at the weekly meetings, the instructors exercising a general direction as to which articles shall be fully reported and discussed and which more cursorily mentioned. A general acquaintance with biological advances, as published in various languages, is thus made possible to all the members, and those working at special topics learn where anything likely to be of importance to them is to be found, without the necessity of undertaking the somewhat laborious task of themselves looking over all the periodicals and the transactions of scientific bodies.

SCHEDULE OF THE BIOLOGICAL INSTRUCTION FOR UNDERGRADUATES.

The regular courses in Biology for undergraduates have hitherto varied somewhat from year to year as the needs of students have become more manifest or the staff has been increased. As now organized the courses given annually are as follows; no great departure from this scheme may be expected in future, except as additions may be made on the appointment of teachers in subjects not yet represented.

First Year's Studies.

1. *General Biology.* PROFESSOR MARTIN. Thrice weekly, from the commencement of the academic year to the end of March.

2. *Embryology.* PROFESSOR MARTIN. Thrice weekly, from the commencement of April to the close of the academic year.

3. *Human and Comparative Osteology.* DR. BROOKS. Thrice weekly, from the beginning of October to the end of April.

Second Year's Studies.

4. *Animal Physiology and Histology;* Elementary Class. PROFESSOR MARTIN. Thrice weekly during the academic year.
In future DR. SEWALL will take charge of this class.

5. *Zoölogy and Comparative Anatomy.* DR. BROOKS. Thrice weekly during the first six months of the academic year.

The Laboratory is open daily for practical instruction in connection with the above courses of lectures and recitations.

COURSES OF LECTURES, 1876-81.

The following list contains the titles of all the formal courses of lectures which have been given in connection with the Biological Department up to the close of the past year. As will be seen many of the courses were annually repeated, as they formed a part of the regular undergraduate instruction; other more advanced lectures were given on varied topics from time to time as the needs of graduate students made it desirable, but most of the graduate instruction, being necessarily adapted to individuals engaged in special advanced work in some one limited direction, is given by means of daily counsel and by informal intercourse and discussion with the Instructors. In all cases, except the courses indicated as public lectures, the lectures are supplemented by daily, systematic, practical laboratory study, the lectures themselves being mainly designed to direct the reading and thought of the student, and to point out to him what are the important facts which he should verify for himself. The special topics of the more advanced lectures vary from year to year, but their general scope and range may be gathered from the list here given, and may be expected rather to be increased than diminished in future.

1876-77.

1. *Animal Physiology.* Professor Martin. Twice weekly, from October to April.

This course was designed mainly for physicians and others who had already a general acquaintance with Human Physiology. The points to which main attention was given were, accordingly, recent physiological advances, as the vasodilator nerves, the physiology of secretion, the localisation of cerebral functions, etc.

2. *The Theories of Biology.* Dr. Brooks. Sixteen public lectures, commencing January 4.

This course was intended to afford an educated audience the opportunity of hearing a critical discussion of such topics as the Origin of Species, Darwin's theory of Pangenesis, Instinct in Animals, etc.

3. *The Anatomy of Invertebrate Animals.* Dr. Brooks. Thrice weekly, from January to the end of the academic year.

In this course, designed to meet the needs of graduate students, the affinities of the groups of Invertebrata, as indicated by their developmental history, were mainly considered. Those attending the lectures were presumed to have a fair knowledge of the anatomy of adult animal forms.

4. *General Biology.* Professor Martin and Dr. Brooks. Thrice weekly, during April and May, 1877.

In this course the structure and physiology of a unicellular fungus, greenplant, and animal were studied; and then several of the higher Fungi, Cryptogams, and Flowering Plants, and a typical Infusorian Cœlenterate, Annulate, Mollusc, and Vertebrate. The course was intended as an introduction to biology for those who had in earlier parts of the session gained some knowledge of physics and chemistry.

5. *The Development of the Chick.* Professor Martin. Ten lectures, May, 1877.

In this course, designed for advanced students, the embryology of the bird was considered in reference to general vertebrate morphology.

1877-78.

6. *Animal Physiology and Histology.* Professor Martin. Thrice weekly, from early in October to the end of March.

This course, planned for undergraduate students, was adapted to the requirements of those who had already learnt the rudiments of Animal Anatomy and Histology the previous year, (see course 4), and also how to use a microscope and to dissect.

7. *Comparative Anatomy and Zoölogy.* Dr. Brooks. Thrice weekly, from the beginning of October to the end of March.

This course, like the preceding, was mainly designed for students who had followed the instruction in General Biology during the preceding academic year.

8. *The Senses and the Brain,* and their relation to Thought. Professor William James, of Harvard University. Ten public lectures.

9. *Elementary Biology.* Professor Martin. Four times weekly, in April and May.

This course was a repetition of course 4.

10. *Animal Embryology,* with a special study of the development of the chick. Dr. Brooks. Eight lectures, in May.

This covered the same ground as course 5, above.

11. *Instruction in Physiology for School Teachers.* Professor Martin. Twenty lectures, with laboratory work, on Saturdays from 10 A. M. to 2 P. M, commencing October 13.

In this course the fundamental points of gross and microscopic structure, and the functions of the more important organs and mechanisms of the mammalian body were studied.

12. *Chesapeake Zoölogical Laboratory,* session of 1878. Dr. Brooks, Director in immediate charge. Open at Fort Wool, Va., from June 15 until the middle of August.

13. *The Structure and Development of Bone and Tooth,* with special reference to the cellular pathology Dr. Christian Sihler, Fellow of the University. Six public lectures, designed for Physicians and Dentists, April, 1878.

1878-79.

14. *General Biology.* Professor Martin. Twenty lectures, delivered in common to a general audience and to students commencing their biological studies. Four times weekly, commencing September 26.

The ground covered was practically the same as in course 4.

15. *Animal Morphology.* Dr. Brooks. Twice weekly, from October 1 to April 8.

This course, delivered to advanced students, was devoted to the Vertebrata.

16. *Zoölogy and Comparative Anatomy.* Dr. Brooks. Twice weekly, from November 4 until the end of April.

This course was designed to meet the needs of undergraduates who had successfully passed through the instruction in General Biology (course 14 above) and who desired especially to study Animal Morphology.

17. *Animal Physiology and Histology,* mainly with reference to the Human Body. Professor Martin. Twice weekly, from November 5 to the end of the academic year.

A course for undergraduates, who, whether intending subsequently to become medical students or not, after taking the introductory course 14, wished especially to study Animal Physiology.

18. *Human Osteology.* Dr. Brooks. Twice weekly, from November 12 to the end of April.

This course was designed for undergraduates as an introduction to Vertebrate Morphology, the human skeleton being selected as a starting point, as that from which the general terminology of Vertebrate Osteology has been adopted, and also as the most accurately known of all Vertebrate skeletons.

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likely to be fully appreciated or intelligently retained.

lasses for School Teachers, and Demonstrations to Medical Students.

Efforts have also been made to extend instruction to persons who could not derive immediate benefit from the University work unless special arrangements were devised for them. In 1877, Professor Martin conducted a class for the Instruction in Physiology of School Teachers. The class met on twenty successive Saturdays from 10 A. M. to 2 P. M. Each meeting commenced with a lecture on the topic of the day's work, and the class then adjourned to the Laboratory for practical study. A syllabus of directions for practical work was drawn up and printed, and an attempt was made to give those attending a fair practical acquaintance with Physiological Anatomy and with Histology, and also to show them how to perform such physiological experiments as are suitable for demonstration in schools; a number of other facts in Physiology were demonstrated with the hope of giving a surer basis for intelligent instruction by the members of the class.

In 1878, Dr. Brooks conducted a similar "Teachers' Class" in Zoölogy, the members of which dissected under his supervision a number of typical Invertebrates; a printed syllabus of directions for dissecting the various animals studied was also drawn up for the use of this class.

In 1878–79 and 1879–80, Prof
series of twenty demonstrations in Animal Phys
class of students from the medical schools of the city
physicians also attending; in these all the fundamenta
logical experiments were shewn.

Fellowships.

Of the twenty Fellowships of the University, each yiel
hundred dollars annually, and awarded among graduates
in advanced study or in research, three are commonly
biological students. A special announcement on this s
made by the University.

Societies.

The Scientific Association of the University meets mor
gives an opportunity for the discussion of recent scien
coveries, and also for the presentation of results of the r
of members of the University. An abstract of the pro
of the Association is published in the "University Ci
which are issued at short intervals during the academic
give those engaged in original work an opportunity t
priority for their discoveries while awaiting an opport
publish their researches in more detail.

Periodical biological literature is so extensive that th
some systematic division of the labor of keeping abrea
early made itself felt. To assist in this task a Journal
been organized, its members being the instructors and
students of the biological department of the Universit
current journals are parcelled out among the memb
in turn report at the weekly meetings, the instruct
cising a general direction as to which articles shall be
ported and discussed and which more cursorily mentio
general acquaintance with biological advances, as pub
various languages, is thus made possible to all the mem
those working at special topics learn where anything li
of importance to them is to be found, without the n
undertaking the somewhat laborious task of themselv
over all the periodicals and the transactions of scient

SCHEDULE OF THE BIOLOGICAL INSTRUCTION FOR UNDERGRADUATE

The regular courses in Biology for undergraduates have hitherto varied somewhat from year to year as the needs of
become more manifest or the staff has been increased. As now organized the courses given annually are as foll
departure from this scheme may be expected in future, except as additions may be made on the appointment of teac
not yet represented.

First Year's Studies.

1. *General Biology.* **Professor Martin.** Thrice weekly, from the commencement of the academic year to the end of March.

2. *Embryology.* **Professor Martin.** Thrice weekly, from the commencement of April to the close of the academic year.

nd *Comparative Osteology.* **Dr. Brooks.** Thrice
October to the end of April.

Second Year's Studies.

4. *Animal Physiology and Histology;*
Professor Martin. Thrice weekly during
In future Dr. Sewall will take charge

5. *Zoölogy and Comparative An*
weekly during the first six month

The Laboratory is open
tion with the above

19. *Instruction in Human Histology for Medical Students.* Henry Sewall, S. B., Fellow of the University. Sixteen practical lessons in Microscopic Anatomy, on Wednesday and Saturday afternoons, commencing March 22.

20. *The Physiology of Sensation.* Professor Martin. Ten lectures, commencing September 30.

21. *The Physiology and Histology of the Spinal Cord and the Sporadic Ganglia.* Professor Martin. Ten lectures, commencing November 11.

22. *The Chemistry of Nutrition.* Professor Martin. Six lectures, commencing January 6.

23. *The Development of the Tissues.* Professor Martin. Six lectures, commencing February 17.

The four preceding courses were planned to meet the wants of advanced students in the Laboratory, and each member of the class was presumed to have already a fair text-book knowledge of the subjects discussed.

24. *The Elements of Embryology, Human and Comparative.* Professor Martin and Dr. Brooks. Twice weekly, from April 18 to the end of the academic year.

25. *Instruction in Zoölogy for School Teachers.* Dr. Brooks. Fifteen lessons, with laboratory work, 10 A. M. to 2 P. M., on Saturdays, commencing November 16.

26. *Demonstrations in Physiology for Medical Students.* Professor Martin. Wednesday afternoons, commencing October 9.

In this course, to which physicians and medical students in the city who were not members of the Johns Hopkins University were admitted, the fundamental facts in Mammalian Physiology were demonstrated.

27. *Vegetable Morphology.* Professor Farlow of Harvard University. Twenty-four lectures, commencing April 15.

28. *Selected Botanical Subjects.* Professor Farlow. Six public lectures, commencing May 2.

29. *Chesapeake Zoölogical Laboratory*, session of 1879. Dr. Brooks, Director in immediate charge; Dr. S. F. Clarke, Fellow of the Johns Hopkins University, Assistant. Open at Crisfield and Fort Wool from June 25 until September 13.

1879-80.

30. *General Biology.* Professor Martin. Thrice weekly, from the commencement of the academic year to the end of April.

In this course, which is an extension of course 4, undergraduate students studied several additional plants, and a type from each class, instead of each sub-kingdom, of animals.

31. *Human and Comparative Osteology.* Dr Brooks. Twice weekly, from the commencement of the academic year to April.

An introduction to Vertebrate Morphology for undergraduate students.

32. *The Physiology of the Senses.* Professor Martin. Twice weekly, from the beginning of October to April.

In this course, designed for advanced students of Physiology already acquainted with the fundamental facts in the topics considered, more than three-fourths of the lectures were devoted to the Sense of Sight, as affording a specially available theme for the general discussion and illustration of the Physiology of Sensation. In future years other senses will be selected for the same extended treatment.

33. *Animal Morphology.* Dr. Brooks. Lectures or recitations four times weekly, from the commencement of the academic year to the end of April.

In this course, adapted to advanced students, the Invertebrates were mainly considered.

34. *Vertebrate Embryology.* Professor Martin. Twice weekly, from April to the close of the academic year.

This course was, in the main, a repetition of course 5, above.

35. *The Structure and Development of the Crab and Oyster.* Dr. Brooks. Four public lectures, in February.

36. *Demonstrations in Physiology to Medical Students.* Professor Martin. Fifteen experimental lectures, commencing October 15.

This course was essentially a repetition of that described above, as number 26.

37. *Instruction in Microscopic Anatomy for Medical Students.* Dr. C. Sihler, Assistant in Biology. Eighteen practical lessons, commencing March 6.

38. *The Chesapeake Zoölogical Laboratory*, session of 1880. Dr. Brooks, Director in immediate charge. Open at Beaufort, N. C., for advanced study, from the beginning of May until September 15.

39. *Elementary Summer School for the Study of Marine Zoölogy.* Dr. S. F. Clarke, formerly Fellow and Assistant in Biology of the Johns Hopkins University, in charge. Opened at Fort Wool, Va., July 15, for a session of six weeks.

1880-81.

The following list gives the courses of lectures which were commenced in 1880, and also those which are, so far, planned for that portion of the academic year which falls within 1881.

40. *General Biology.* Professor Martin. Two lectures and a recitation weekly, from the commencement of the academic year to the end of March.

Mr. Sedgwick, Ph. B., Yale, formerly Fellow of the Johns Hopkins University and now Assistant in Biology, directs the details of the Laboratory work and conducts the recitations.

The course is in essentials a repetition of 30 above.

41. *Animal Physiology.* Professor Martin. Two lectures and a recitation weekly, throughout the academic year.

Dr. Sewall, Associate in Biology and Assistant Professor of Physiology, takes charge of the weekly recitation and supervises the daily laboratory work. This course is designed for students in the second year of their biological studies.

42. *Human and Comparative Osteology.* Dr. Brooks. Five lectures or recitations weekly, from December 1 to the end of March.

43. *The Construction, Theory, and Employment of Physiological Instruments.* Dr. Sewall. Twenty lectures illustrated by the apparatus belonging to the Biological Laboratory, commencing November 1.

In this course the method of using the various instruments employed in physiological experiment is illustrated; the limits of error are discussed, and an account of the main results which have been arrived at by the use of various instruments is given.

Before the close of the session, Professor Martin will lecture on Embryology, Dr. Brooks will give a short course on Anthropology, August Schimper, Ph. D., Strassburg, Fellow of the University, will lecture on Vegetable Physiology, and Mr. Sedgwick, Ph. B., Yale, Assistant in Biology, will conduct an elementary class in Systematic and Structural Botany in connection with the Naturalists' Field Club.

CHESAPEAKE ZOÖLOGICAL LABORATORY.

A marine station or seaside dependency of the Biological Department of the University has been open for advanced study and research each summer since 1878, under the immediate charge of Dr. W. K. Brooks, Associate of the University and Assistant Professor of Comparative Anatomy.

Session of 1878.

The Seaside Laboratory was opened on June 24th at Fort Wool, in Hampton Roads, Va., for a session of eight weeks. The party consisted of

W. K. BROOKS, Ph. D., Director.
H. J. RICE, S. B., Fellow, Johns Hopkins University.
H. SEWALL, S. B., Assistant in Biology, Johns Hopkins University.
C. SIHLER, M. D., Fellow, Johns Hopkins University.
AUGUST SCHMIDT, Teacher of Natural Science, Baltimore.
N. B. WEBSTER, Principal, Webster Military Academy, Norfolk, Va.
T. B. WEBSTER, Norfolk, Va.

The above remained during the whole session; P. R. UHLER, Associate of the University and President of the Maryland Academy of Sciences, and W. D. BOOKER, M. D., were present for a part of the time.

The fauna of Hampton Roads proved to be very interesting, and it not only afforded a good supply of material for elementary work, which was preserved for class use in Baltimore during the ensuing winter, but furnished ample opportunities for original investigation.

Among the interesting forms of life which were most abundant the following may be mentioned: Sagitta, Appendicularia, Tornaria and Balanoglossus, Pilidium, Actinotrocha and other interesting trochic larvae, Squilla, Porcellana, Amphioxus and Lingula in all stages of development, and many others of great scientific interest.

An abundant supply of material for work upon the adult structure and the development of the Sponges, Hydroids, Medusae, Ctenophora, Gephyreans, Annelids, Crustacea, Tunicates, Polyzoa, Brachiopods, Lamellibranchs, Gasteropods and lower Vertebrates was within easy reach.

A number of papers, giving an account of the scientific work of the party, were published together as "Scientific Results of the Chesapeake Zoölogical Laboratory, 1878," forming part 3 of Vol. I of "Studies from the Biological Laboratory," under which head a list of them will be found. Two illustrated papers on the Structure and Habits of Amphioxus were also published by H. J. Rice in the American Naturalist.

The experience gained in 1878 shewed that some of those then received as students were hardly fitted to carry on the advanced work for which the Marine Laboratory was designed; hence somewhat more care has since been exercised in selection in order to ensure that those received are qualified to profit by the opportunities offered.

Session of 1879.

This year the University coöperated with Major W. B. Ferguson of the Maryland Fish Commission, in order to undertake the study of the oyster beds of Tangier Sound on the eastern side of the Chesapeake. The Laboratory was accordingly opened on June 25th at Crisfield, on three barges provided by the Maryland Fish Commission and with the advantage of the use of the Fish Commission yacht, the Lookout, for dredging purposes. Crisfield, while excellent for the special study of the oyster beds, proved a disadvantageous locality in other respects, and the Laboratory, on August 8th, removed to its former quarters at Fort Wool, where the session was continued until September 15th.

The party consisted of

W. K. BROOKS, Ph. D., Director.
S. F. CLARKE, Ph. D., Fellow, Johns Hopkins University, Assistant.
B. W. BARTON, M. D., Baltimore.
EMIL BESSELS, M. D., Smithsonian Institution.
H. C. EVARTS, M. D., Academy of Natural Sciences, Philadelphia.
K. MITSUKURI, Ph. B., Graduate Student, Johns Hopkins University.
E. A. NUNN, Professor of Biology, Wellesley College.
H. J. RICE, S. B., late Fellow, Johns Hopkins University.
AUGUST SCHMIDT, Baltimore.
C. SIHLER, M. D., Fellow, Johns Hopkins University.
E. B. WILSON, Ph. B., Fellow, Johns Hopkins University.

Among the subjects studied by the members of the party were the development and propagation of the Oyster; the structure and growth of Hydroids; the development of the Crabs; the embryology of the Ctenophora; the life history of the Squid; and the metamorphosis of Actinotrocha.

The fourth part of Vol. I of the "Studies from the Biological Laboratory," with 13 plates, is made up of two papers resulting from the work of this session of the Marine Laboratory; another paper (The Development of the Squid) has been printed, with illustrations, in the Memoirs of the Boston Society of Natural History, and other papers will soon be published.

Session of 1880.

At the beginning of the third session the Marine Laboratory was provided with a steam launch, which was built for the purpose at Bristol, R. I., and arrangements were made to spend a much longer period at the seaside. The session was opened on April 23d at Beaufort, N. C., and closed on September 30th.

A house standing close to the water was hired, and fitted with working accommodations for six investigators; and the facilities which it afforded were used by the following persons:

W. K. BROOKS, Ph. D., Director.
K. MITSUKURI, Ph. B., Fellow, Johns Hopkins University.
E. B. WILSON, Ph. B., Fellow, Johns Hopkins University.
F. W. KING, Professor of Natural Sciences, Wisconsin State Normal School.
H. C. EVARTS, M. D., Academy of Natural Sciences, Philadelphia.
H. F. OSBORNE, B. A., Fellow, College of New Jersey.

Beaufort was selected as being the nearest accessible town, south of Baltimore, favorably situated for marine zoölogical study, and its Fauna was found to be unusually rich and varied; almost every thing which was found at Fort Wool was met with here, as well as very many interesting forms which do not occur further north.

Close to the town there are large sand bars, exposed at low tide, and abounding in animal life. These yielded an abundant supply of Amphioxus, Renilla, Limulus, Balanoglossus, Sea Urchins, and a great variety of Molluscs and Crustacea. The mud flats furnished another fauna and yielded a great variety of Annelids, Gephyreans, Polyps, Ophiurids, Holothurians and Echini, and a series of species of Molluscs and Crustacea different from those found on the sand bars. The large salt marshes gave a third fauna, and a short distance inland large swamps of brackish and fresh water furnished still other conditions and forms of life. As the town is situated at the point where Gore Sound connects Pamlico Sound with Bogue Sound, a large sheet of land-locked water was within easy reach, and this furnished a collecting and dredging ground abounding in Corals, Gorgonidæ, Ascidians, Star Fishes, Sea Urchins, Ophiurids, and still another set of Molluscs and Crustacea.

The stone breakwaters at Fort Macon and the wharves at Morehead City and Beaufort afford a proper habitat for sedentary animals, and yielded a rich supply of Hydroids, Corals, Ascidians, Sea Anemones, Sponges, Cirrhipeds, &c. The ocean beach, within a short distance of the town, furnished still another fauna; and a good locality for ocean dredging could be reached by a sail of three miles from the laboratory.

The greatest attraction of the locality is the richness of its pelagic fauna. The Gulf Stream is constantly sweeping oceanic animals along the North Carolina coast, and as the tide flows through Beaufort Inlet to the Sounds these floating animals are carried with it. Such oceanic animals as Porpita and Physalia were frequently thrown, uninjured and in perfect health, upon the beach within twenty feet of the laboratory.

These attractions, together with the mild and uniform oceanic climate which enables the student to work with perfect comfort during the hottest months of summer, fully justified the selection of this locality.

During the summer the following abstracts of the more important results of the season's work were published in this country and in Germany, and more detailed accounts are now in preparation.

The Development of the Cephalopoda and the Homology of the Cephalopod Foot, by W. K. **Brooks**. *American Journal of Science.*

The Development of Annelids, by E. B. **Wilson**. *American Journal of Science*

The Rhythmical Nature of Segmentation, by W. K. **Brooks**. *American Journal of Science.*

The Origin of the Metamorphosis of Actinotrocha, by E. B. **Wilson**. *American Association, Boston meeting.*

Notes on the Medusæ of Beaufort, by W. K. **Brooks**. *American Association, Boston meeting.*

Budding in free Medusæ, by W. K. **Brooks**. *American Naturalist.*

Development of Marine Polychaetous Annelids, by E. B. **Wilson**. *Zoölogischer Anzeiger, Leipzig.*

Embryology and Metamorphosis of Lucifer, by W. K. **Brooks**. *Zoölogischer Anzeiger.*

The Early Stages of Renilla, by E. B. **Wilson**. *Zoölogischer Anzeiger.*

Announcement for the Session of 1881.

The fourth session of the laboratory will commence at Beaufort, May 2, and will continue until the end of August. Dr. W. K. **Brooks**, Associate in Biology and Assistant Professor of Comparative Anatomy, will be in immediate charge as Director.

The laboratory is provided with a steam launch; small boats, nets, dredges, aquaria, microscopes, reagents, and a small reference library are also supplied by the University. For their use, those admitted to the Laboratory will be charged a fee of $ 25.

The Marine Laboratory is designed for advanced students and for those qualified to carry on original investigation. Members of this University will have the first claim to accommodation, but a few other naturalists can probably be also received. Persons desiring to join the party are requested to send applications to Dr. H. Newell Martin, Professor of Biology, and, if not holding public positions which indicate the possession of an adequate knowledge of Zoölogy, to supplement the application by such a statement as to previous work or training as will make it possible to decide whether the applicant is qualified to profit by the opportunities offered. Suitable candidates will be accepted so far as the accomodations of the Laboratory permit, and tickets of admission will be issued on payment of the fee to the Treasurer of the University in Baltimore. No definite courses of instruction will be given, as the persons received will be presumed to have sufficient knowledge to carry on their studies without such aid; Dr. Brooks will, however, exercise a general supervision, and control and direct the daily work of the Laboratory.

ELEMENTARY SEASIDE SCHOOL.

Announcement for 1881.

During about six weeks of the coming summer, commencing early in July, there will be an elementary class in Marine Zoölogy in connection with the station at Beaufort; daily lectures will be given and arrangements made for systematic work in the laboratory. On every day when the weather is favorable there will be a dredging or collecting expedition, in which part of the elementary class will be allowed to join.

The Director of the Chesapeake Zoölogical Laboratory for advanced students will exercise personal supervision of the work of the elementary class, and will give a course of lectures on General Zoölogy, but the students will be under the more immediate guidance of Dr. S. F. **Clarke**, formerly Fellow of the University and subsequently Assistant in Biology, who will lecture daily upon the structure and habits of marine animals, and will superintend the work in the laboratory.

Applicants for admission to the elementary class will be required to satisfy Professor Martin, by examination or otherwise, that they are qualified for admission into the Biological Department of the University, and they will be required to attend the whole course, and to devote themselves to study, although, bearing in mind that most of the students will probably have just finished a year's collegiate study elsewhere, the work in the laboratory will be so arranged as to leave abundant time for out-door life, and for the enjoyment of fishing, boating, and bathing.

The fee for instruction and for the use of apparatus and of specimens for laboratory work will be $25 for the course of five weeks, payable to the Treasurer of the University in Baltimore; and his receipt will serve as a ticket of admission to the class at the laboratory.

Should any of the members of this class be found qualified for special work in the laboratory for advanced students they will be allowed to study there during the rest of the season without extra charge.

Board and lodging can be obtained in the town of Beaufort, within a short distance of the laboratory, for from $20 to $30 a month. The diversified fauna of this locality, together with its mild and uniform climate, renders it a desirable place for study during the hot months of summer.

LIST OF BIOLOGICAL PAPERS,

Published by Members of the University.

September, 1876, to December, 1880.

Only articles published during the connection of the author with the Biological Department or based on work carried on in it are here included.

BY I. E. ATKINSON, M. D.

The Botanical Relations of Tricophyton Tonsurans. (*New York Medical Journal, December*, 1878; *Studies from the Biological Laboratory, Vol. I, pt.* 1, 1879, *pp.* 15).

BY W. D. BOOKER, M. D. *See H. N. Martin.*

BY W. K. BROOKS, PH. D.

A Remarkable Life-History. (*American Naturalist, November*, 1876, *pp.* 16).

A Provisional Hypothesis of Pangenesis. (*American Naturalist, March*, 1877, *pp.* 4).

Parthenogenesis in Vertebrates and Molluscs. (*American Naturalist, October*, 1877, *pp.* 2).

Preliminary Observations upon the Development of the Marine Prosobranchiate Gasteropods. (*Studies from the Biological Laboratory, Vol. I, pt.* 1, 1879, *pp.* 22; 1 *plate*).

The Development of Lingula and the Systematic Position of the Branchiopoda. (*Studies from the Biological Laboratory, Vol. I, pt.* 3, 1879, *pp.* 78; 6 *plates*).

The Larval Stages of Squilla Empusa. (*Studies from the Biological Laboratory, Vol. I, pt.* 3, 1879, *pp.* 28; 5 *plates*).

Observations upon the Early Stages in the Development of the Fresh Water Pulmonates. (*Studies from the Biological Laboratory, Vol. I, pt.* 2, 1880, *pp.* 32; 4 *plates*).

The Development of the Digestive Tract in Molluscs. (*Proceedings, Boston Society of Natural History*, 1879, *Vol. XX, pp.* 4.)

Abstract of Observations on the Development of the American Oyster. (*Zoölogischer Anzeiger*, 1879, *pp.* 2).

The Artificial Fertilization of Oyster Eggs and the Propagation of the American Oyster. (*American Journal of Science*, 1880, *pp.* 3).

The Development of the American Oyster. (*Report of the Maryland Fish Commission*, 1880; *Studies from the Biological Laboratory, Vol. I, pt.* 4, 1880, *pp.* 101; 10 *plates*).

The Acquisition and Loss of a Food Yolk in Molluscan Eggs. (*Studies from the Biological Laboratory, Vol. I, pt.* 4, 1880, *pp.* 10; 1 *plate*).

The Development of the Cephalopoda and the Homology of the Cephalopod Foot. (*American Journal of Science*, 1880, *pp.* 3).

The Rhythmical Character of Segmentation. (*American Journal of Science*, 1880).

Budding in Free Medusae. (*American Naturalist*, 1880).

Embryology and Metamorphosis of Lucifer. (*Zoölogischer Anzeiger*, 1880, *pp.* 5).

The Early Stages of the Squid. (*Memorial Volume, Boston Society of Natural History*, 1880, *pp.* 20; 4 *plates*).

BY S. F. CLARKE, PH. D.

Hydroids of Alaska. (*Academy of Natural Sciences, Philadelphia*, 1876; *Smithsonian Institution*, 1876).

Hydroids of the Gulf Stream and Gulf of Mexico. (*Bulletin of the Museum of Comparative Zoölogy, Cambridge, Mass.*, 1879).

Development of Amblystoma punctatum. Baird. (*Studies from the Biological Laboratory, Vol. I, pt.* 2, 1880, *pp.* 21; 4 *plates*).

BY WALTER FAXON, PH. D.

Description of Lucifer typus. (*Studies from the Biological Laboratory, Vol. I, pt.* 3, 1879, *pp.* 7; 1 *plate*.) Paper based on specimens forwarded to Professor Faxon from the Marine Laboratory.

BY E. M. HARTWELL, A. M.

The Legal Status of Anatomical Science. (*Journal of Social Science*, 1880).

American Anatomy Acts; six articles. (*Boston Medical and Surgical Journal*, 1880).

The Earliest English and American Medical Acts. (*Boston Medical and Surgical Journal*, 1880).

——— *also see H. N. Martin.*

BY WILLIAM LEE, M. D.

The Effect of Stimulation on an Excised Nerve. (*New York Medical Record*, 1877, *pp.* 6).

BY PROFESSOR MARTIN.

The Normal Respiratory Movements of the Frog and the Influence upon its Respiratory Centre of Stimulation of the Optic Lobes. (*Journal of Physiology*, 1878; *Studies from the Biological Laboratory, Vol. I, pt.* 1, 1879, *pp.* 40; 1 *plate*).

A self-feeding Chronograph Pen. (*Studies from the Biological Laboratory, Vol. I, pt.* 2, 1880, *pp.* 3; *with wood cut*).

BY PROFESSOR MARTIN AND W. D. BOOKER, M. D.

The Influence of Stimulation of the Midbrain upon the Respiratory Rhythm of the Mammal. (*Journal of Physiology*, 1878; *Studies from the Biological Laboratory, Vol. I, pt.* 1, 1879, *pp.* 7; 1 *plate*).

BY PROFESSOR MARTIN AND E. M. HARTWELL, A. M.

On the Respiratory Function of the Internal Intercostal Muscles. (*Journal of Physiology*, 1879; *Studies from the Biological Laboratory, Vol. I, pt.* 2, 1880, *pp.* 4; 1 *plate*).

BY ISAAC OTT, M. D.

Sweat-Centres. The Action of Muscarin and Atropin on them. (*Journal of Physiology*, 1878, *pp.* 3).

Observations on the Spinal Cord. (*Journal of Physiology*, 1879; *Studies from the Biological Laboratory, Vol. I, pt.* 2, 1880, *pp.* 24; 2 *plates*).

BY H. J. RICE, S. B.

Observations upon the Hatching, Variation, and Development of the Raritan River Smelt, Osmerus eperlanus. (*Report of Maryland Fish Commission*, 1878).

Notes upon the Development of the Shad, Alosa sapidissima. (*Report of Maryland Fish Commission*, 1878).

Observations upon the Habits, Structure and Development of Amphioxus lanceolatus. (*American Naturalist, January, February*, 1880, *pp.* 42; 2 *plates. Translated in Journal de Micrographie, Paris*, 1880).

BY W. T. SEDGWICK, Ph. B.

The Influence of Quinine upon the Reflex-excitability of the Spinal Cord. (*Journal of Physiology*, 1880, *pp.* 16).

BY HENRY SEWALL, PH. D.

Development and Regeneration of Gastric Glandular Epithelium during Fœtal Life and after Birth. (*Journal of Physiology*, 1878; *Studies from the Biological Laboratory, Vol. I, pt.* 1, 1879, *pp.* 14; 1 *plate*).

On the effect of Two Succeeding Stimuli upon Muscular Contraction. (*Journal of Physiology*, 1879; *Studies from the Biological Laboratory, Vol. I, pt.* 1, 1880, *pp.* 27; 1 *plate*).

BY CHRISTIAN SIHLER, M. D.

On the so-called Heat-Dyspnœa. (*Journal of Physiology*, 1879; *Studies from the Biological Laboratory, Vol. I, pt.* 2, 1880, *pp.* 12).

Some Further Observations on Heat-Dyspnœa. (*Journal of Physiology*, 1880; *Studies from the Biological Laboratory, Vol. I, pt.* 2, 1880, *pp.* 10).

BY P. R. UHLER.

List of Animals observed at Fort Wool, Va. (*Studies from the Biological Laboratory, Vol. I, pt.* 3, 1879, *pp.* 18).

BY N. B. WEBSTER.

Partial List of the Land Plants found at Fort Wool, Va. (*Studies from the Biological Laboratory, Vol. I, pt.* 3, 1879, *pp.* 2).

BY E. B. WILSON, Ph. B.

Preliminary Abstract of Observations on the Early Stages of some Polychaetous Annelides. (*Zoölogischer Anzeiger*, 1880, *pp.* 2).

Notes on the Early Stages of some Polychaetous Annelides. (*American Journal of Science*, 1880, *pp.* 2).

The Metamorphosis of Actinotrocha. (*American Association, Boston Meeting*, 1880; *abstract in American Naturalist*, 1880).

The Early Stages of Renilla. (*American Journal of Science*, 1880, *pp.* 3; 1 *plate*).

LIST OF PERIODICALS.

The following list contains an enumeration of the principal periodicals, devoted either wholly or partially to the publication of articles on biological topics, which are taken by the Library of the Johns Hopkins University, the Library of the Peabody Institute, and by the Medical and Chirurgical Faculty of Maryland; a perusal of it will shew that nearly all important periodical biological literature is readily accessible to Baltimore students.

The publications of learned societies are usually given under the name of the place where the meetings are held. The University Library is designated by H. The Peabody Library is designated by P. The Medical Library is designated by M. A complete set is indicated by an asterisk; as H*, P*.

American assoc'n for the advancement of sci.: Proceedings. Salem, &c.	H. P.*
American entomological society: Transactions. Philadelphia.	P.*
American entomologist. New York.	H.
American gynecological society: Transactions. Boston.	H.*
American journal of conchology. Philadelphia.	P.
American journal of insanity. Utica.	M. P.*
American journal of medical sciences. Philadelphia.	M.
American journal of microscopy. New York.	M.
American journal of obstetrics. New York.	M.
American jour. of science and arts (Silliman & Dana.) New Haven.	H. P.
American naturalist. Boston and Philadelphia	H. P.*
American public health association: Reports. New York.	P.*
Annales des sciences naturelles: Botanique Paris.	H. P.*
Zoologie et paléontologie. Paris.	H. P.*
Annals and magazine of natural history. London.	P.*
Année scientifique: (Figuier). Paris	H.*
Annual record of science and industry. New York.	H. P.*
Archiv für anatomie und physiologie. (Braune u. Reymond.) Leipzig.	H. P.*
Archiv für die gesammte physiologie. (Pflüger.) Bonn.	H.*
Archiv für experimentelle pathologie. Leipzig.	H.
Archiv for mathematik og naturvidenskab. Kristiania.	H.*
Archiv für mikroskopische anatomie. (Schultze.) Bonn.	H. P.*
Archiv für naturgeschichte. Berlin.	H. P.*
Archiv für ohrenheilkunde. Leipzig.	H.
Archiv für ophthalmologie (Græfe) Berlin.	H.
Archiv für pathologische anatomie. (Virchow.) Berlin.	H.*
Archives de biologie. Gand et Leipzig.	H.*
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THE JOURNAL OF PHYSIOLOGY.

Edited by Dr. MICHAEL FOSTER, F. R. S., of Trinity College, Cambridge, England.

With the coöperation in England of Prof. A. GAMGEE, F. R. S., *Owens College, Manchester;* Prof. W. RUTHERFORD, F. R. S., *The University of Edinburgh;* Prof. J. B. SANDERSON, F. R. S., *University College, London.*

And in America of Prof. H. P. BOWDITCH, *Harvard Medical School, Boston;* Prof. H. N. MARTIN, *Johns Hopkins University, Baltimore;* Prof. H. C. WOOD, *University of Pennsylvania, Philadelphia.*

This Journal, which is the only one in the English language devoted solely to the publication of original physiological articles, will in future be published in America with the aid of the Johns Hopkins University.

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A special feature of the Journal is a list of titles of books and papers on subjects of physiological interest which appears in each number, and which it is endeavored to make complete for all languages. This list is reprinted in a separate form at the end of each volume and given to each subscriber. A worker, away from centres of physiological activity, is thus enabled to learn quickly what others are doing in reference to the particular topic he may be interested in; while the classified reprints form a complete physiological bibliography for future reference.

The subscription price is $5 per volume when supplied direct to subscribers; after the completion of the present volume no reduction will be made to the trade. American subscriptions should be sent to Professor H. Newell Martin, Johns Hopkins University.

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STUDIES FROM THE BIOLOGICAL LABORATORY.

Editor, Professor MARTIN. Associate Editor, Dr. W. K. BROOKS.

The "Studies from the Biological Laboratory of the Johns Hopkins University," appear in parts from time to time as sufficient material accumulates; they contain reprints of original papers upon Physiology, Animal and Vegetable Morphology, and Embryology, published by members of the University in various Scientific Journals, and other biological papers by members of the University which have not been printed elsewhere. Each part contains about 100 pages and four parts make a volume. The first volume is now complete and contains 519 pages, and 40 plates, besides illustrations in the text: with the following table of contents. A few copies of No. 1, Vol. I, may still be obtained; the rest of the volume is out of print. Part 1, Vol. II, is now in preparation.

The Editors will be glad to entertain propositions of exchange from Institutions or Societies which issue scientific publications.

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With four Plates and three Illustrations in the text.

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Brooks, W. K. The Development of the American Oyster.
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With eleven Plates.

Preliminary Courses of Instruction for those who intend, at a later day, to begin the study of Medicine.

I. COLLEGIATE COURSE.

To obtain the degree of Bachelor of Arts in the Johns Hopkins University, a student must, first, pass the matriculation examination, and secondly, pursue at least five courses of study, selected from those provided by the University, and pass satisfactory examinations in them. Of the five courses required, two must be what are known as "major courses," *i. e.* the examination test will call for so much knowledge as an ordinary student (commencing with the training implied by his passing the matriculation examination) could acquire in about two years' work; the other three courses demanded are "minor courses," requiring one year's fair work for their completion. On an average, about three years' study after matriculation will be necessary for graduation, but candidates unusually well prepared at the beginning or of more than common ability, may take the degree in less time; while, on the other hand, those who so wish may extend their studies over a longer period.

Among these collegiate courses leading to the B. A. degree is one especially recommended to those who intend hereafter to study Medicine. This is so planned as to give those students who follow it a liberal education equivalent to that afforded by the other courses leading to the same degree. The principal studies in this course are Physics, Chemistry, and Biology, since it is especially desirable that this class of students should enjoy the resources for scientific instruction to be found in an endowed university with well equipped laboratories. Below is a summary of the complete course; the order in which the studies are there allotted, definite ones to each year, is that which is recommended, and which will usually be insisted upon, by the University authorities.

Graduates of a college in good repute are admitted to the course without any entrance examination, and may devote their attention especially to the scientific subjects.

Matriculation.

The examinations for matriculation take place twice yearly, at the beginning of June, and in the latter part of September.

Informal preliminary examinations may be held from time to time, by mutual agreement between the candidates and the examiners, for the purpose of ascertaining whether a student should be encouraged to present himself for the matriculation examination, and of giving him counsel as to the progress of his studies. To persons at a distance blank forms of application will be forwarded, upon the return of which, properly filled out, the candidates will be advised as to the expediency of their coming to Baltimore.

The special requirements for matriculation are as follows:

Latin. Grammar, Prosody and Composition; *Cæsar*, 5 books; *Ovid*, 2500 verses (500 elegiac); *Virgil*, Æneid, 6 books, and Eclogues; *Cicero*, 7 orations; *Livy*, 1 book; *Horace*, Odes, 2 books.

Greek. Grammar, Prosody and Composition; *Xenophon*, Anabasis, 4 books; *Homer*, Iliad, 4 books; *Herodotus*, 1 book; any one drama.

The accurate reading at sight of passages previously unseen may render unnecessary the examination in the books above specified.

Mathematics. *Arithmetic*, including the Metric System; *Algebra*, Todhunter, 38 chapters; *Geometry*, plane and solid, Chauvenet; *Plane Trigonometry*, Chauvenet, 8 chapters; *Analytic Geometry*, Straight Line and Circle in rectangular coördinates, Salmon (Conic Sections) or Howison.

The subjects named, in both Mathematics and Language, merely indicate the range of the examination Equivalents are accepted.

German and French. Candidates who intend to graduate through this course may offer French and German instead of Greek. They will be expected to display a knowledge of the elements of the grammar of those languages, and to translate at sight passages of ordinary French and German prose.

English. All candidates for admission will be expected to satisfy the authorities that, in addition to the studies in Mathematics and Language required for admission, they have been well trained in the ordinary English branches, including the use of the English Language, Geography, and the History of the United States.

Natural Science. Each candidate for admission must offer for examination some branch of Natural Science. Physical Geography is recommended as within the reach of all. An elementary acquaintance with Botany, Zoölogy, or Natural Philosophy will be accepted as a substitute.

Summary of the Course.

First Year's Studies.

1. Physics.
2. Chemistry.
3. German.*
4. Drawing.

Second Year's Studies.

1. Chemistry.
2. General Biology (Elements of Botany, Zoölogy, and Embryology).
3. French.*

Third Year's Studies.

1. Comparative Anatomy.
2. Physiology.
3. Any one of the minor courses for the B. A. degree. Mathematics, Logic and Psychology, and the English Language and Literature, are especially recommended to students if they have not already taken those subjects as substitutes for a minor course in French or German.

Additional Studies.

Besides the regular work in recitation-room or laboratory, students have the opportunity of attending in the University a large number of lectures on literary and scientific subjects. While attendance on these will not always be required, and the results of listening to them will not necessarily be scrutinized by examination, it is believed that they will furnish to the earnest student, while his time and care are chiefly given to the prosecution of his strictly collegiate work, a valuable opportunity for enlarging his general culture.

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*Candidates who have shown at the matriculation examination that they can read ordinary French or German prose, may substitute for those subjects any of the remaining minor courses leading to the B. A. degree.

course such as is requisite for attaining the B. A. degree, are of considerable importance. It practically extends the time occupied in medical studies, and gives the student a sound, if elementary, scientific education as a basis for his technical studies. Physiology in a medical school is, of necessity, nearly always "Human Physiology," which the experience of late years has taught us is as unscientific, studied by itself, as the so-called "Physiological Chemistry." Medical Physiology should be taught on a broader basis of General Physiology, as Medical Chemistry on a previously acquired knowledge of General Chemistry; it is only then that the practical applications of physiological facts, which form the proper field of instruction in a medical school, are likely to be fully appreciated or intelligently retained.

Classes for School Teachers, and Demonstrations to Medical Students.

Efforts have also been made to extend instruction to persons who could not derive immediate benefit from the University work unless special arrangements were devised for them. In 1877, Professor Martin conducted a class for the Instruction in Physiology of School Teachers. The class met on twenty successive Saturdays from 10 A. M. to 2 P. M. Each meeting commenced with a lecture on the topic of the day's work, and the class then adjourned to the Laboratory for practical study. A syllabus of directions for practical work was drawn up and printed, and an attempt was made to give those attending a fair practical acquaintance with Physiological Anatomy and with Histology, and also to show them how to perform such physiological experiments as are suitable for demonstration in schools; a number of other facts in Physiology were demonstrated with the hope of giving a surer basis for intelligent instruction by the members of the class.

In 1878, Dr. Brooks conducted a similar "Teachers' Class" in Zoölogy, the members of which dissected under his supervision a number of typical Invertebrates; a printed syllabus of directions for dissecting the various animals studied was also drawn up for the use of this class.

In 1878–79 and 1879–80, Professor Martin conducted two series of twenty demonstrations in Animal Physiology before a class of students from the medical schools of the city, several physicians also attending; in these all the fundamental physiological experiments were shewn.

Fellowships.

Of the twenty Fellowships of the University, each yielding five hundred dollars annually, and awarded among graduates engaged in advanced study or in research, three are commonly held by biological students. A special announcement on this subject is made by the University.

Societies.

The Scientific Association of the University meets monthly and gives an opportunity for the discussion of recent scientific discoveries, and also for the presentation of results of the researches of members of the University. An abstract of the proceedings of the Association is published in the "University Circulars," which are issued at short intervals during the academic year, and give those engaged in original work an opportunity to secure priority for their discoveries while awaiting an opportunity to publish their researches in more detail.

Periodical biological literature is so extensive that the need of some systematic division of the labor of keeping abreast with it early made itself felt. To assist in this task a Journal Club has been organized, its members being the instructors and graduate students of the biological department of the University. The current journals are parcelled out among the members, who in turn report at the weekly meetings, the instructors exercising a general direction as to which articles shall be fully reported and discussed and which more cursorily mentioned. A general acquaintance with biological advances, as published in various languages, is thus made possible to all the members, and those working at special topics learn where anything likely to be of importance to them is to be found, without the necessity of undertaking the somewhat laborious task of themselves looking over all the periodicals and the transactions of scientific bodies.

SCHEDULE OF THE BIOLOGICAL INSTRUCTION FOR UNDERGRADUATES.

The regular courses in Biology for undergraduates have hitherto varied somewhat from year to year as the needs of students have become more manifest or the staff has been increased. As now organized the courses given annually are as follows; no great departure from this scheme may be expected in future, except as additions may be made on the appointment of teachers in subjects not yet represented.

First Year's Studies.

1. *General Biology.* PROFESSOR MARTIN. Thrice weekly, from the commencement of the academic year to the end of March.

2. *Embryology.* PROFESSOR MARTIN. Thrice weekly, from the commencement of April to the close of the academic year.

3. *Human and Comparative Osteology.* DR. BROOKS. Thrice weekly, from the beginning of October to the end of April.

Second Year's Studies.

4. *Animal Physiology and Histology;* Elementary Class. PROFESSOR MARTIN. Thrice weekly during the academic year.
In future DR. SEWALL will take charge of this class.

5. *Zoölogy and Comparative Anatomy.* DR. BROOKS. Thrice weekly during the first six months of the academic year.

The Laboratory is open daily for practical instruction in connection with the above courses of lectures and recitations.

COURSES OF LECTURES, 1876-81.

The following list contains the titles of all the formal courses of lectures which have been given in connection with the Biological Department up to the close of the past year. As will be seen many of the courses were annually repeated, as they formed a part of the regular undergraduate instruction; other more advanced lectures were given on varied topics from time to time as the needs of graduate students made it desirable, but most of the graduate instruction, being necessarily adapted to individuals engaged in special advanced work in some one limited direction, is given by means of daily counsel and by informal intercourse and discussion with the Instructors. In all cases, except the courses indicated as public lectures, the lectures are supplemented by daily, systematic, practical laboratory study, the lectures themselves being mainly designed to direct the reading and thought of the student, and to point out to him what are the important facts which he should verify for himself. The special topics of the more advanced lectures vary from year to year, but their general scope and range may be gathered from the list here given, and may be expected rather to be increased than diminished in future.

1876-77.

1. *Animal Physiology.* **Professor Martin.** Twice weekly, from October to April.

This course was designed mainly for physicians and others who had already a general acquaintance with Human Physiology. The points to which main attention was given were, accordingly, recent physiological advances, as the vasodilator nerves, the physiology of secretion, the localisation of cerebral functions, etc.

2. *The Theories of Biology.* **Dr. Brooks.** Sixteen public lectures, commencing January 4.

This course was intended to afford an educated audience the opportunity of hearing a critical discussion of such topics as the Origin of Species, Darwin's theory of Pangenesis, Instinct in Animals, etc.

3. *The Anatomy of Invertebrate Animals.* **Dr. Brooks.** Thrice weekly, from January to the end of the academic year.

In this course, designed to meet the needs of graduate students, the affinities of the groups of Invertebrata, as indicated by their developmental history, were mainly considered. Those attending the lectures were presumed to have a fair knowledge of the anatomy of adult animal forms.

4. *General Biology.* **Professor Martin** and **Dr. Brooks.** Thrice weekly, during April and May, 1877.

In this course the structure and physiology of a unicellular fungus, greenplant, and animal were studied; and then several of the higher Fungi, Cryptogams, and Flowering Plants, and a typical Infusorian Cœlenterate, Annulate, Mollusc, and Vertebrate. The course was intended as an introduction to biology for those who had in earlier parts of the session gained some knowledge of physics and chemistry.

5. *The Development of the Chick.* **Professor Martin.** Ten lectures, May, 1877.

In this course, designed for advanced students, the embryology of the bird was considered in reference to general vertebrate morphology.

1877-78.

6. *Animal Physiology and Histology.* **Professor Martin.** Thrice weekly, from early in October to the end of March.

This course, planned for undergraduate students, was adapted to the requirements of those who had already learnt the rudiments of Animal Anatomy and Histology the previous year, (see course 4), and also how to use a microscope and to dissect.

7. *Comparative Anatomy and Zoölogy.* **Dr. Brooks.** Thrice weekly, from the beginning of October to the end of March.

This course, like the preceding, was mainly designed for students who had followed the instruction in General Biology during the preceding academic year.

8. *The Senses and the Brain,* and their relation to Thought. **Professor William James,** of Harvard University. Ten public lectures.

9. *Elementary Biology.* **Professor Martin.** Four times weekly, in April and May.

This course was a repetition of course 4.

10. *Animal Embryology,* with a special study of the development of the chick. **Dr. Brooks.** Eight lectures, in May.

This covered the same ground as course 5, above.

11. *Instruction in Physiology for School Teachers.* **Professor Martin.** Twenty lectures, with laboratory work, on Saturdays from 10 A. M. to 2 P. M, commencing October 13.

In this course the fundamental points of gross and microscopic structure, and the functions of the more important organs and mechanisms of the mammalian body were studied.

12. *Chesapeake Zoölogical Laboratory,* session of 1878. **Dr. Brooks,** Director in immediate charge. Open at Fort Wool, Va., from June 15 until the middle of August.

13. *The Structure and Development of Bone and Tooth,* with special reference to the cellular pathology **Dr. Christian Sihler,** Fellow of the University. Six public lectures, designed for Physicians and Dentists, April, 1878.

1878-79.

14. *General Biology.* **Professor Martin.** Twenty lectures, delivered in common to a general audience and to students commencing their biological studies. Four times weekly, commencing September 26.

The ground covered was practically the same as in course 4.

15. *Animal Morphology.* **Dr. Brooks.** Twice weekly, from October 1 to April 8.

This course, delivered to advanced students, was devoted to the Vertebrata.

16. *Zoölogy and Comparative Anatomy.* **Dr. Brooks.** Twice weekly, from November 4 until the end of April.

This course was designed to meet the needs of undergraduates who had successfully passed through the instruction in General Biology (course 14 above) and who desired especially to study Animal Morphology.

17. *Animal Physiology and Histology,* mainly with reference to the Human Body. **Professor Martin.** Twice weekly, from November 5 to the end of the academic year.

A course for undergraduates, who, whether intending subsequently to become medical students or not, after taking the introductory course 14, wished especially to study Animal Physiology.

18. *Human Osteology.* **Dr. Brooks.** Twice weekly, from November 12 to the end of April.

This course was designed for undergraduates as an introduction to Vertebrate Morphology, the human skeleton being selected as a starting point, as that from which the general terminology of Vertebrate Osteology has been adopted, and also as the most accurately known of all Vertebrate skeletons.

swamps of brackish and fresh water furnished still other conditions and forms of life. As the town is situated at the point where Gore Sound connects Pamlico Sound with Bogue Sound, a large sheet of land-locked water was within easy reach, and this furnished a collecting and dredging ground abounding in Corals, Gorgonidæ, Ascidians, Star Fishes, Sea Urchins, Ophiurids, and still another set of Molluscs and Crustacea.

The stone breakwaters at Fort Macon and the wharves at Morehead City and Beaufort afford a proper habitat for sedentary animals, and yielded a rich supply of Hydroids, Corals, Ascidians, Sea Anemones, Sponges, Cirrhipeds, &c. The ocean beach, within a short distance of the town, furnished still another fauna; and a good locality for ocean dredging could be reached by a sail of three miles from the laboratory.

The greatest attraction of the locality is the richness of its pelagic fauna. The Gulf Stream is constantly sweeping oceanic animals along the North Carolina coast, and as the tide flows through Beaufort Inlet to the Sounds these floating animals are carried with it. Such oceanic animals as Porpita and Physalia were frequently thrown, uninjured and in perfect health, upon the beach within twenty feet of the laboratory.

These attractions, together with the mild and uniform oceanic climate which enables the student to work with perfect comfort during the hottest months of summer, fully justified the selection of this locality.

During the summer the following abstracts of the more important results of the season's work were published in this country and in Germany, and more detailed accounts are now in preparation.

The Development of the Cephalopoda and the Homology of the Cephalopod Foot, by W. K. Brooks. *American Journal of Science.*

The Development of Annelids, by E. B. Wilson. *American Journal of Science*

The Rhythmical Nature of Segmentation, by W. K. Brooks. *American Journal of Science.*

The Origin of the Metamorphosis of Actinotrocha, by E. B. Wilson. *American Association, Boston meeting.*

Notes on the Medusæ of Beaufort, by W. K. Brooks. *American Association, Boston meeting.*

Budding in free Medusæ, by W. K. Brooks. *American Naturalist.*

Development of Marine Polychaetous Annelids, by E. B. Wilson. *Zoölogischer Anzeiger, Leipzig.*

Embryology and Metamorphosis of Lucifer, by W. K. Brooks. *Zoölogischer Anzeiger.*

The Early Stages of Renilla, by E. B. Wilson. *Zoölogischer Anzeiger.*

Announcement for the Session of 1881.

The fourth session of the laboratory will commence at Beaufort, May 2, and will continue until the end of August. Dr. W. K. Brooks, Associate in Biology and Assistant Professor of Comparative Anatomy, will be in immediate charge as Director.

The laboratory is provided with a steam launch; small boats, nets, dredges, aquaria, microscopes, reagents, and a small reference library are also supplied by the University. For their use, those admitted to the Laboratory will be charged a fee of $ 25.

The Marine Laboratory is designed for advanced students and for those qualified to carry on original investigation. Members of this University will have the first claim to accommodation, but a few other naturalists can probably be also received. Persons desiring to join the party are requested to send applications to Dr. H. Newell Martin, Professor of Biology, and, if not holding public positions which indicate the possession of an adequate knowledge of Zoölogy, to supplement the application by such a statement as to previous work or training as will make it possible to decide whether the applicant is qualified to profit by the opportunities offered. Suitable candidates will be accepted so far as the accomodations of the Laboratory permit, and tickets of admission will be issued on payment of the fee to the Treasurer of the University in Baltimore. No definite courses of instruction will be given, as the persons received will be presumed to have sufficient knowledge to carry on their studies without such aid; Dr. Brooks will, however, exercise a general supervision, and control and direct the daily work of the Laboratory.

ELEMENTARY SEASIDE SCHOOL.

Announcement for 1881.

During about six weeks of the coming summer, commencing early in July, there will be an elementary class in Marine Zoölogy in connection with the station at Beaufort; daily lectures will be given and arrangements made for systematic work in the laboratory. On every day when the weather is favorable there will be a dredging or collecting expedition, in which part of the elementary class will be allowed to join.

The Director of the Chesapeake Zoölogical Laboratory for advanced students will exercise personal supervision of the work of the elementary class, and will give a course of lectures on General Zoölogy, but the students will be under the more immediate guidance of Dr. S. F. Clarke, formerly Fellow of the University and subsequently Assistant in Biology, who will lecture daily upon the structure and habits of marine animals, and will superintend the work in the laboratory.

Applicants for admission to the elementary class will be required to satisfy Professor Martin, by examination or otherwise, that they are qualified for admission into the Biological Department of the University, and they will be required to attend the whole course, and to devote themselves to study, although, bearing in mind that most of the students will probably have just finished a year's collegiate study elsewhere, the work in the laboratory will be so arranged as to leave abundant time for out-door life, and for the enjoyment of fishing, boating, and bathing.

The fee for instruction and for the use of apparatus and of specimens for laboratory work will be $25 for the course of five weeks, payable to the Treasurer of the University in Baltimore; and his receipt will serve as a ticket of admission to the class at the laboratory.

Should any of the members of this class be found qualified for special work in the laboratory for advanced students they will be allowed to study there during the rest of the season without extra charge.

Board and lodging can be obtained in the town of Beaufort, within a short distance of the laboratory, for from $20 to $30 a month. The diversified fauna of this locality, together with its mild and uniform climate, renders it a desirable place for study during the hot months of summer.

LIST OF BIOLOGICAL PAPERS,

Published by Members of the University.

September, 1876, to December, 1880.

Only articles published during the connection of the author with the Biological Department or based on work carried on in it are here included.

By I. E. Atkinson, M. D.

The Botanical Relations of Tricophyton Tonsurans. (*New York Medical Journal, December, 1878; Studies from the Biological Laboratory, Vol. I, pt. 1, 1879, pp. 15*).

By W. D. Booker, M. D. *See H. N. Martin.*

By W. K. Brooks, Ph. D.

A Remarkable Life-History. (*American Naturalist, November, 1876, pp. 16*).

A Provisional Hypothesis of Pangenesis. (*American Naturalist, March, 1877, pp. 4*).

Parthenogenesis in Vertebrates and Molluscs. (*American Naturalist, October, 1877, pp. 2*).

Preliminary Observations upon the Development of the Marine Prosobranchiate Gasteropods. (*Studies from the Biological Laboratory, Vol. I, pt. 1, 1879, pp. 22; 1 plate*).

The Development of Lingula and the Systematic Position of the Branchiopoda. (*Studies from the Biological Laboratory, Vol. I, pt. 3, 1879, pp. 78; 6 plates*).

The Larval Stages of Squilla Empusa. (*Studies from the Biological Laboratory, Vol. I, pt. 3, 1879, pp. 28; 5 plates*).

Observations upon the Early Stages in the Development of the Fresh Water Pulmonates. (*Studies from the Biological Laboratory, Vol. I, pt. 2, 1880, pp. 32; 4 plates*).

The Development of the Digestive Tract in Molluscs. (*Proceedings, Boston Society of Natural History, 1879, Vol. XX, pp. 4.*)

Abstract of Observations on the Development of the American Oyster. (*Zoölogischer Anzeiger, 1879, pp. 2*).

The Artificial Fertilization of Oyster Eggs and the Propagation of the American Oyster. (*American Journal of Science, 1880, pp. 3*).

The Development of the American Oyster. (*Report of the Maryland Fish Commission, 1880; Studies from the Biological Laboratory, Vol. I, pt. 4, 1880, pp. 101; 10 plates*).

The Acquisition and Loss of a Food Yolk in Molluscan Eggs. (*Studies from the Biological Laboratory, Vol. I, pt. 4, 1880, pp. 10; 1 plate*).

The Development of the Cephalopoda and the Homology of the Cephalopod Foot. (*American Journal of Science, 1880, pp. 3*).

The Rhythmical Character of Segmentation. (*American Journal of Science, 1880*).

Budding in Free Medusae. (*American Naturalist, 1880*).

Embryology and Metamorphosis of Lucifer. (*Zoölogischer Anzeiger, 1880, pp. 5*).

The Early Stages of the Squid. (*Memorial Volume, Boston Society of Natural History, 1880, pp. 20; 4 plates*).

By S. F. Clarke, Ph. D.

Hydroids of Alaska. (*Academy of Natural Sciences, Philadelphia, 1876; Smithsonian Institution, 1876*).

Hydroids of the Gulf Stream and Gulf of Mexico. (*Bulletin of the Museum of Comparative Zoölogy, Cambridge, Mass., 1879*).

Development of Amblystoma punctatum. Baird. (*Studies from the Biological Laboratory, Vol. I, pt. 2, 1880, pp. 21; 4 plates*).

By Walter Faxon, Ph. D.

Description of Lucifer typus. (*Studies from the Biological Laboratory, Vol. I, pt. 3, 1879, pp. 7; 1 plate.*) Paper based on specimens forwarded to Professor Faxon from the Marine Laboratory.

By E. M. Hartwell, A. M.

The Legal Status of Anatomical Science. (*Journal of Social Science, 1880*).

American Anatomy Acts; six articles. (*Boston Medical and Surgical Journal, 1880*).

The Earliest English and American Medical Acts. (*Boston Medical and Surgical Journal, 1880*).

——— *also see H. N. Martin.*

By William Lee, M. D.

The Effect of Stimulation on an Excised Nerve. (*New York Medical Record, 1877, pp. 6*).

By Professor Martin.

The Normal Respiratory Movements of the Frog and the Influence upon its Respiratory Centre of Stimulation of the Optic Lobes. (*Journal of Physiology, 1878; Studies from the Biological Laboratory, Vol. I, pt. 1, 1879, pp. 40; 1 plate*).

A self-feeding Chronograph Pen. (*Studies from the Biological Laboratory, Vol. I, pt. 2, 1880, pp. 3; with wood cut*).

By Professor Martin and W. D. Booker, M. D.

The Influence of Stimulation of the Midbrain upon the Respiratory Rhythm of the Mammal. (*Journal of Physiology, 1878; Studies from the Biological Laboratory, Vol. I, pt. 1, 1879, pp. 7; 1 plate*).

By Professor Martin and E. M. Hartwell, A. M.

On the Respiratory Function of the Internal Intercostal Muscles. (*Journal of Physiology, 1879; Studies from the Biological Laboratory, Vol. I, pt. 2, 1880, pp. 4; 1 plate*).

By Isaac Ott, M. D.

Sweat-Centres. The Action of Muscarin and Atropin on them. (*Journal of Physiology, 1878, pp. 3*).

Observations on the Spinal Cord. (*Journal of Physiology, 1879; Studies from the Biological Laboratory, Vol. I, pt. 2, 1880, pp. 24; 2 plates*).

By H. J. Rice, S. B.

Observations upon the Hatching, Variation, and Development of the Raritan River Smelt, Osmerus eperlanus. (*Report of Maryland Fish Commission, 1878*).

Notes upon the Development of the Shad, Alosa sapidissima. (*Report of Maryland Fish Commission, 1878*).

Observations upon the Habits, Structure and Development of Amphioxus lanceolatus. (*American Naturalist, January, February, 1880, pp. 42; 2 plates. Translated in Journal de Micrographie, Paris, 1880*).

By W. T. Sedgwick, Ph. B.

The Influence of Quinine upon the Reflex-excitability of the Spinal Cord. (*Journal of Physiology, 1880, pp. 16*).

By Henry Sewall, Ph. D.

Development and Regeneration of Gastric Glandular Epithelium during Fœtal Life and after Birth. (*Journal of Physiology, 1878; Studies from the Biological Laboratory, Vol. I, pt. 1, 1879, pp. 14; 1 plate*).

On the effect of Two Succeeding Stimuli upon Muscular Contraction. (*Journal of Physiology, 1879; Studies from the Biological Laboratory, Vol. I, pt. 1, 1880, pp. 27; 1 plate*).

By Christian Sihler, M. D.

On the so-called Heat-Dyspnœa. (*Journal of Physiology, 1879; Studies from the Biological Laboratory, Vol. I, pt. 2, 1880, pp. 12*).

Some Further Observations on Heat-Dyspnœa. (*Journal of Physiology, 1880; Studies from the Biological Laboratory, Vol. I, pt. 2, 1880, pp. 10*).

By P. R. Uhler.

List of Animals observed at Fort Wool, Va. (*Studies from the Biological Laboratory, Vol. I, pt. 3, 1879, pp. 18*).

By N. B. Webster.

Partial List of the Land Plants found at Fort Wool, Va. (*Studies from the Biological Laboratory, Vol. I, pt. 3, 1879, pp. 2*).

By E. B. Wilson, Ph. B.

Preliminary Abstract of Observations on the Early Stages of some Polychaetous Annelides. (*Zoölogischer Anzeiger, 1880, pp. 2*).

Notes on the Early Stages of some Polychaetous Annelides. (*American Journal of Science, 1880, pp. 2*).

The Metamorphosis of Actinotrocha. (*American Association, Boston Meeting, 1880; abstract in American Naturalist, 1880*).

The Early Stages of Renilla. (*American Journal of Science, 1880, pp. 3; 1 plate*).

LIST OF PERIODICALS.

The following list contains an enumeration of the principal periodicals, devoted either wholly or partially to the publication of articles on biological topics, which are taken by the Library of the Johns Hopkins University, the Library of the Peabody Institute, and by the Medical and Chirurgical Faculty of Maryland; a perusal of it will shew that nearly all important periodical biological literature is readily accessible to Baltimore students.

The publications of learned societies are usually given under the name of the place where the meetings are held. The University Library is designated by H. The Peabody Library is designated by P. The Medical Library is designated by M. A complete set is indicated by an asterisk; as H*, P*.

American assoc'n for the advancement of sci.: Proceedings. Salem, &c.	H. P.*
American entomological society: Transactions. Philadelphia.	P.*
American entomologist. New York.	H.
American gynecological society: Transactions. Boston.	H.*
American journal of conchology. Philadelphia.	P.
American journal of insanity. Utica.	M. P.*
American journal of medical sciences. Philadelphia.	M.
American journal of microscopy. New York.	M.
American journal of obstetrics. New York.	M.
American jour. of science and arts (Silliman & Dana.) New Haven.	H. P.
American naturalist. Boston and Philadelphia.	H. P.*
American public health association: Reports. New York.	P.*
Annales des sciences naturelles: Botanique. Paris.	H. P.*
Zoologie et paléontologie. Paris.	H. P.*
Annals and magazine of natural history. London.	P.*
Année scientifique: (Figuier). Paris	H.*
Annual record of science and industry. New York.	H. P.*
Archiv für anatomie und physiologie. (Braune u. Reymond.) Leipzig.	H. P.*
Archiv für die gesammte physiologie. (Pflüger.) Bonn.	H.*
Archiv für experimentelle pathologie. Leipzig.	H.
Archiv for mathematik og naturvidenskab. Kristiania.	H.*
Archiv für mikroskopische anatomie. (Schultze.) Bonn.	H. P.*
Archiv für naturgeschichte. Berlin.	H. P.*
Archiv für ohrenheilkunde. Leipzig.	H.
Archiv für ophthalmologie (Græfe) Berlin.	H.
Archiv für pathologische anatomie. (Virchow.) Berlin.	H.*
Archives de biologie. Gand et Leipzig.	H.*
Archives de physiologie normale. Paris.	H. P.*
Archives de zoologie expérimentale et générale. Paris.	H. P.*
Archives of dermatology. New York.	M.
Archives of ophthalmology. New York.	M.
Archives of otology. New York.	M.
Archivio per le scienze mediche. Torino.	H.
Berlin. Königliche akad. d. wissensch: Monatsberichte.	H. P.*
Berliner klinische wochenschrift.	M.
Boston. Society of natural history: Memoirs. Journal. Proceedings.	P.*
Boston medical and surgical journal.	M.
Botanical magazine. (Curtis.) London.	P.*
Botanische zeitung. Leipzig.	H. P.*
Brain. London.	H.*
Braithwaite's retrospect. New York.	M.
British assoc'n for the advancement of sci.: Proceedings. London.	H. P.*
Reports. London.	H. P.*
British medical journal. London.	M.
Brussels. Académie royale (belge) des sciences: Bulletins.	H. P.*
Memoires.	P.*
Buffalo. Academy of science: Bulletin.	P.*
California academy of natural science: Proceedings. San Francisco.	P.*
Cambridge (Mass.) Museum of comparative zoölogy: Bulletin.	P.*
Illust'd catalogues.	P.*
Canadian naturalist and quarterly journal of science. Montreal.	P.*
Centralblatt für die medicinischen wissenschaften. Berlin.	M. H.
Chicago. Academy of science: Transactions.	P.
Chicago medical journal and examiner.	M.
Chicago medical times.	M.
Cincinnati lancet and clinic.	M.
Connecticut academy of arts and sciences: Transactions.	H. P.*
Country practitioner. Beverly, N. J.	M.*
Deutsche akademie der naturforscher: Nova acta.	P.*
Dublin. Royal Irish academy: Transactions.	P.*
Dublin medical journal.	M.
Edinburgh. Royal society: Transactions.	H. P.
Edinburgh medical journal.	M.
Entomologische zeitung. Stettin.	P.*
France. Government publications.	P.
Göttingen. Königliche gesellschaft der wissenschaften: Nachrichten.	H. P*
Gaillard's medical journal. New York.	M.
Gazette des hôpitaux.	M.
Gazette hebdomadaire de médicine et de chirurgie. Paris.	M.
Great Britain and Ireland. Government publications.	P.
Half-yearly compendium of medical science. Philadelphia.	M.
Heidelberg. Untersuch a. d. physiolog. institut.	H.
Independent practitioner. Baltimore.	M.
Index medicus. New York.	M. H.
Institut de France. Académie de sciences: Comptes rendus.	H. P.*
Mémoires.	P.*
Jahrbücher für wissenschaftliche botanik. Leipzig.	H.
Jahresber. über die fortsch. der anat und physiol. (Hofmann u. Schwalbe) Leipzig. (Contin. of Bericht. Hensle-Meissner.)	H.*
Jahresber. über die fortsch in d thier chemie.	H.
Jahresber. uber die leistungen und fortschritte in der anatomie und physiologie. (Virchow und Hirsch.) Berlin.	H.
Jahresber. über die leistungen und forschritte in d. gesammt. medicin.	H.
Jenaische zeitschrift für naturwissenschaft.	H.
Journal de l'anatomie et physiologie. Paris.	H.
Journal de zoologie. Paris.	H.
Journal of anatomy and physiology. Cambridge and London.	H.
Journal of conchology. London.	H.
Journal of mental science. London.	H.
Journal of nervous and mental diseases. Chicago.	M.
Journal of physiology. Cambridge and Baltimore.	H.*
Kosmos. Leipzig.	H.
Lancet. London.	M. H. P.
Leonard's illustrated medical journal. Detroit.	M.
Leyden. Nederlandsche dierkundige vereen: Tijdschrift.	H.
Liege: Societé royale des sciences: Mémoires.	H. P.*
London. Anthropological institute: Journal.	P.*
Chirurgical society: Transactions.	M.
Entomological society: Transactions.	P.*
Ethnological society: Journal.	P.*
Transactions.	P.*
Guy's hospital reports.	P.*
Linnean society: Journal.	M P.*
Proceedings.	P.*
Transactions.	P.*
Medico-chirurgical society: Transactions.	M.
New Sydenham society: Publications.	P.*
Obstetrical society: Transactions.	M.
Pathological society: Transactions.	M.
Ray society: Publications.	P.*
Royal society: Philosophical transactions.	H. P.*
Proceedings	H. P.*
St Bartholomew's hospital reports.	M.
Zoölogical society: Proceedings.	P.*
Transactions.	P.*
London medical record.	M.
Maryland. Medical and chirurgical faculty: Transactions.	M. H. P.
Maryland medical journal. Baltimore.	M.
Medical advance. Cincinnati.	M.
Medical and surgical reporter. Philadelphia.	M.
Medical gazette. New York.	M.
Medical news and abstract. Philadelphia.	M.
Medical record. New York.	M.
Medical summary. Lansdale, Pa.	M.
Medical times and gazette. London.	M. H.
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THE JOURNAL OF PHYSIOLOGY.

Edited by Dr. MICHAEL FOSTER, F. R. S., of Trinity College, Cambridge, England.

With the coöperation in England of Prof. A. Gamgee, F. R. S., *Owens College, Manchester;* Prof. W. Rutherford, F. R. S., *The University of Edinburgh;* Prof. J. B. Sanderson, F. R. S., *University College, London.*

And in America of Prof. H. P. Bowditch, *Harvard Medical School, Boston;* Prof. H. N. Martin, *Johns Hopkins University, Baltimore;* Prof. H. C. Wood, *University of Pennsylvania, Philadelphia.*

This Journal, which is the only one in the English language devoted solely to the publication of original physiological articles, will in future be published in America with the aid of the Johns Hopkins University.

It is issued in numbers which appear not at rigidly fixed times but at intervals, varying from two to three months, determined by the supply of material. Six numbers, in from four to six parts, form a volume of about five hundred pages. By this method of publication a high standard of excellence is maintained, as there is no necessity to accept inferior matter which may come to hand, so as to fill up a number by a given date. As a rule the issue of a volume covers about a year.

A special feature of the Journal is a list of titles of books and papers on subjects of physiological interest which appears in each number, and which it is endeavored to make complete for all languages. This list is reprinted in a separate form at the end of each volume and given to each subscriber. A worker, away from centres of physiological activity, is thus enabled to learn quickly what others are doing in reference to the particular topic he may be interested in; while the classified reprints form a complete physiological bibliography for future reference.

The subscription price is $5 per volume when supplied direct to subscribers; after the completion of the present volume no reduction will be made to the trade. American subscriptions should be sent to Professor H. Newell Martin, Johns Hopkins University.

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STUDIES FROM THE BIOLOGICAL LABORATORY.

Editor, Professor MARTIN. Associate Editor, Dr. W. K. BROOKS.

The "Studies from the Biological Laboratory of the Johns Hopkins University," appear in parts from time to time as sufficient material accumulates; they contain reprints of original papers upon Physiology, Animal and Vegetable Morphology, and Embryology, published by members of the University in various Scientific Journals, and other biological papers by members of the University which have not been printed elsewhere. Each part contains about 100 pages and four parts make a volume. The first volume is now complete and contains 519 pages, and 40 plates, besides illustrations in the text: with the following table of contents. A few copies of No. 1, Vol. I, may still be obtained; the rest of the volume is out of print. Part 1, Vol. II, is now in preparation.

The Editors will be glad to entertain propositions of exchange from Institutions or Societies which issue scientific publications.

Contents of Vol. I, Part 1.

Martin, H. Newell. The Normal Respiratory Movements of the Frog and the Influence upon its Respiratory Centre of Stimulation of the Optic Lobes.
Sewall, H. The Development and Regeneration of the Gastric Glandular Epithelium during Fœtal Life and after Birth.
Martin, H. Newell and Booker, W. D. The Influence of Stimulation of the Midbrain upon the Respiratory Rhythm of the Mammal.
Atkinson, I. E. The Botanical Relations of Trichophyton tonsurans.
Brooks, W. K. Preliminary Observations upon the Development of the Marine Prosobranchiate Mollusca.

With four Plates and three Illustrations in the text.

Contents of Vol. I, Part 2.

Martin, H. Newell and Hartwell, Edward M. On the Respiratory Function of the Internal Intercostal Muscles.
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With thirteen Plates.

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With eleven Plates.

Preliminary Courses of Instruction for those who intend, at a later day, to begin the study of Medicine.

I. COLLEGIATE COURSE.

To obtain the degree of Bachelor of Arts in the Johns Hopkins University, a student must, first, pass the matriculation examination, and secondly, pursue at least five courses of study, selected from those provided by the University, and pass satisfactory examinations in them. Of the five courses required, two must be what are known as "major courses," *i. e.* the examination test will call for so much knowledge as an ordinary student (commencing with the training implied by his passing the matriculation examination) could acquire in about two years' work; the other three courses demanded are "minor courses," requiring one year's fair work for their completion. On an average, about three years' study after matriculation will be necessary for graduation, but candidates unusually well prepared at the beginning or of more than common ability, may take the degree in less time; while, on the other hand, those who so wish may extend their studies over a longer period.

Among these collegiate courses leading to the B. A. degree is one especially recommended to those who intend hereafter to study Medicine. This is so planned as to give those students who follow it a liberal education equivalent to that afforded by the other courses leading to the same degree. The principal studies in this course are Physics, Chemistry, and Biology, since it is especially desirable that this class of students should enjoy the resources for scientific instruction to be found in an endowed university with well equipped laboratories. Below is a summary of the complete course; the order in which the studies are there allotted, definite ones to each year, is that which is recommended, and which will usually be insisted upon, by the University authorities.

Graduates of a college in good repute are admitted to the course without any entrance examination, and may devote their attention especially to the scientific subjects.

Matriculation.

The examinations for matriculation take place twice yearly, at the beginning of June, and in the latter part of September.

Informal preliminary examinations may be held from time to time, by mutual agreement between the candidates and the examiners, for the purpose of ascertaining whether a student should be encouraged to present himself for the matriculation examination, and of giving him counsel as to the progress of his studies. To persons at a distance blank forms of application will be forwarded, upon the return of which, properly filled out, the candidates will be advised as to the expediency of their coming to Baltimore.

The special requirements for matriculation are as follows:

Latin. Grammar, Prosody and Composition; *Cæsar*, 5 books; *Ovid*, 2500 verses (500 elegiac); *Virgil*, Æneid, 6 books, and Eclogues; *Cicero*, 7 orations; *Livy*, 1 book; *Horace*, Odes, 2 books.

Greek. Grammar, Prosody and Composition; *Xenophon*, Anabasis, 4 books; *Homer*, Iliad, 4 books; *Herodotus*, 1 book; any one drama.

The accurate reading at sight of passages previously unseen may render unnecessary the examination in the books above specified.

Mathematics. *Arithmetic*, including the Metric System; *Algebra*, Todhunter, 38 chapters; *Geometry*, plane and solid, Chauvenet; *Plane Trigonometry*, Chauvenet, 8 chapters; *Analytic Geometry*, Straight Line and Circle in rectangular coördinates, Salmon (Conic Sections) or Howison.

The subjects named, in both Mathematics and Language, merely indicate the range of the examination Equivalents are accepted.

German and French. Candidates who intend to graduate through this course may offer French and German instead of Greek. They will be expected to display a knowledge of the elements of the grammar of those languages, and to translate at sight passages of ordinary French and German prose.

English. All candidates for admission will be expected to satisfy the authorities that, in addition to the studies in Mathematics and Language required for admission, they have been well trained in the ordinary English branches, including the use of the English Language, Geography, and the History of the United States.

Natural Science. Each candidate for admission must offer for examination some branch of Natural Science. Physical Geography is recommended as within the reach of all. An elementary acquaintance with Botany, Zoölogy, or Natural Philosophy will be accepted as a substitute.

Summary of the Course.

First Year's Studies.

1. Physics.
2. Chemistry.
3. German.*
4. Drawing.

Second Year's Studies.

1. Chemistry.
2. General Biology (Elements of Botany, Zoölogy, and Embryology).
3. French.*

Third Year's Studies.

1. Comparative Anatomy.
2. Physiology.
3. Any one of the minor courses for the B. A. degree. Mathematics, Logic and Psychology, and the English Language and Literature, are especially recommended to students if they have not already taken those subjects as substitutes for a minor course in French or German.

Additional Studies.

Besides the regular work in recitation-room or laboratory, students have the opportunity of attending in the University a large number of lectures on literary and scientific subjects. While attendance on these will not always be required, and the results of listening to them will not necessarily be scrutinized by examination, it is believed that they will furnish to the earnest student, while his time and care are chiefly given to the prosecution of his strictly collegiate work, a valuable opportunity for enlarging his general culture.

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*Candidates who have shown at the matriculation examination that they can read ordinary French or German prose, may substitute for those subjects any of the remaining minor courses leading to the B. A. degree.

Explanation of the Course.

Physics. The course in Physics is the regular minor course. It includes three recitations, two lectures, and one exercise in the Physical Laboratory, weekly, through a year.

Elementary Mechanics will be studied during the first portion of the year; then will follow, in the order named, the study of the Physical Properties of Matter, Theory of Undulations, Acoustics, Heat, Magnetism, Electricity, and Light.

The lectures have as their aim the elucidation, by means of experimental demonstrations, of the subjects pursued by the class.

One morning of each week will be assigned for the work in the laboratory. This work will be selected with two principal ends in view: First, To give the student a clearer insight into the subjects studied, serving as a test of progress both to teacher and learner; and, Second, to enable him to acquire a familiarity with the use of apparatus. The manner of conducting the exercise will be as follows: with the enunciation of a problem, each student will receive the apparatus necessary for its solution, and will be required to make the series of observations which, with their discussion and reduction, he is to submit to his instructor. These results will then be criticised and returned. Those who are aiming at the profession of medicine will thus grow familiar with physical instruments and methods which are of prime importance in physiological researches, together with such practical subjects as thermometry, the laws governing the phenomena of electricity, of light, etc. A knowledge of plane trigonometry is in all cases requisite before entering on this course.

Chemistry. The course in Chemistry is the regular major course. During the first year it includes attendance on daily lectures and recitations on General Chemistry, and daily work in the laboratory. During the first half of the second year the student will attend lectures on Analytical Chemistry three times weekly, besides working in the laboratory; and during the remainder of this year will attend lectures four times weekly on the Chemistry of Carbon Compounds.

The instruction in the laboratory will be directed in such a way as seems best adapted to give the student a thorough knowledge of the pure science of chemistry and the methods peculiar to it. This kind of instruction is considered to be the best basis, whatever the object may be which the student has in view.

At first the student will make himself acquainted with the action of the various classes of substances upon each other, by actual observation at the laboratory desk; and his knowledge will be constantly tested by means of appropriate problems given him for solution. After completing this course, he will be enabled further to test his acquirements by taking up a course of qualitative and quantitative analysis. At intervals during the time he is engaged in this work he will be required to prepare chemical compounds in a pure state, so that his ideas concerning chemical action may become enlarged, and his knowledge of the special properties of the different classes of compounds more definite and detailed.

Biology. The course required is the regular major course, (except that, for prospective medical students, Mammalian Anatomy is recommended instead of general Comparative Anatomy in the second year; those who prefer may, however, take Comparative Anatomy instead.)

The course is designed to give the student, in the first place, a knowledge of the laws of life in general, whether exhibited in animals or plants; and secondly, a special knowledge of Mammalian Anatomy and Animal Physiology. Human Physiology is taught as a part of general physiological science, the student being left to acquire its clinical and hygienic applications as part of his medical studies proper; and, similarly, human anatomy is left for the medical school curriculum. It is believed that by approaching these sciences from a general scientific standpoint the student will be best prepared for the study of pathological structure and function; and that a great advantage will result from his being able to concentrate his attention on the professional applications of the biological sciences when he enters a medical school.

The order of biological study will be as follows:

1. *General Biology.*—Lectures, recitations, or examinations, three times weekly throughout one year, with daily laboratory instruction. This course is intended to bring prominently before the student the fundamental phenomena presented by living things, as gathered from the detailed study of a number of typical plants, and of a specimen from each of the main groups of the animal kingdom The embryonic development of the chick is also studied in detail. In this course beginners are taught how to use the microscope and to dissect.

2. *Human and Comparative Osteology* —Seventy lectures and recitations. The human skeleton being that most accurately and minutely described, and also that from which the greater part of the nomenclature of comparative osteology is derived, the student commences with it, and then proceeds to the examination of a number of typical vertebrate skeletons, the majority being, however, selected from among the mammals.

The biological studies of the final year include:

3. *Zoölogy and Comparative Anatomy.*—In this course the student is taught the principles of classification adopted in the animal kingdom and the characters of the various recognized classes and orders. He also studies in great detail the anatomy of one of the mammals, working in the same manner as a medical student on the human subject in the dissecting room. He thus acquires skill in dissecting and a thorough practical knowledge of the structure and arrangement of osseous, muscular, vascular, nervous, alimentary, &c., systems in the Mammalia, so that on subsequently entering the dissecting-room of a medical school his necessary work will be largely reduced in amount, and he will be to a great extent ready to turn his attention at once to the technical minutiæ of Anthropotomy

4. *Animal Physiology and Histology.*—Mainly with reference to the human body. Two lectures and an examination weekly throughout the academic year. The microscopic structure of the tissues and organs is studied in this course, except so much as may already have been completed in the General Biology course. Students are required to perform for themselves the simpler physiological experiments, while others, more difficult but important, are demonstrated to them. The physiological apparatus belonging to the University is unusually good and complete; and students who follow this course will acquire a knowledge of the method of using all the chief instruments employed in physiological research; and, so it is hoped, will be qualified to carry out afterwards scientific investigations on the physiological action of drugs, in experimental pathology, etc.

5. From time to time short advanced courses of lectures on special physiological topics are delivered.

German and French. A minor course is required from those who take up these subjects. In this, students receive such instruction as should enable them to read at sight ordinary French and German, to render English into French and German, and to understand French and German grammar.

Drawing. The amount of skill demanded is such as will enable the student to represent a bone, a dissection, or a microscopic preparation with accuracy.

English. The minor course in English includes the critical study of a play of Shakespeare, of the elements of Anglo-Saxon, and of selections from Chaucer.

It aims at giving an insight into the history and genius of the language, and at increasing the student's facility and power in the use of it as an instrument of expression.

Mathematics. The minor course includes: (*a*) Conic Sections, and (*b*) Differential Calculus.

Logic and Psychology. A course of study in these subjects will be definitely announced hereafter.

II. COURSE FOR NON-MATRICULATED STUDENTS.

While the University authorities are desirous, and use their influence, to induce all prospective medical students to take the above complete college course, it is, nevertheless, found that many such students apply for admission without being able to pass the full matriculation examination, or to take up all the studies required for graduation. The Trustees, believing that many of these candidates would derive substantial benefit from the full courses of Scientific Instruction provided in the University, have arranged to admit to certain portions of the Course Antecedent to the Study of Medicine, those undergraduates who can pass an entrance examination less strict than that for the regular University matriculation, but still such as to show that they have had a fairly good preliminary education. The subsequent studies extend throughout three years, and are primarily intended to ensure that the student has a good knowledge (based largely on practical laboratory study) of Physics, Chemistry and Biology. Such non-matriculated students are not recognized as candidates for the B. A. degree.

Entrance Examination.

The requirements for entrance to this course are as follows:

English. Candidates will be examined in the whole of Lounsbury's History of the English Language, and will be required to satisfy the examiner, by means of a written composition, of their ability to express themselves in correct and idiomatic English, properly spelled, punctuated, and divided into paragraphs.

Elementary Mathematics. Arithmetic; Algebra; three books of Euclid, or an equivalent amount of Geometry; Plane Trigonometry, and the use of Logarithms.

The examination in Algebra will be confined to the following: definitions and explanations of algebraical signs and terms; addition, subtraction, multiplication and division of algebraical quantities; ratio, proportion and variation; simple equations involving not more than two unknown quantities.

Latin. Translation of passages from the first four books of Caesar, *De Bello Gallico*, and of the sixth book of the Aeneid; the elements of Latin Grammar, especially Accidence.

Candidates who obtain permission at least a fortnight previously, will be permitted to offer themselves for examination in equivalent portions of other Latin classics than those presented above.

Physical Geography. Guyot's Physical Geography and Huxley's Physiography are recommended as text books.

French and German. In addition to the above subjects, candidates may offer themselves for examinatiom in French and German; those who pass will be excused from attendance upon the instruction in those languages during the subsequent course of study.

The examination in French and German will test the candidate's knowledge of the elements of the Grammar of those languages, and his ability to translate at sight easy passages from prose authors.

Drawing. Some knowledge of Drawing is very desirable; students who are proficient in this subject may omit it from the subsequent course.

Summary of the Course.

First Year's Studies.

1. Experimental Physics.
2. Chemistry.
3. German or French.
4. English Prose Style.
5. Drawing.

Second Year's Studies.

1. Chemistry.
2. General Biology.
3. Human and Comparative Osteology.
4. French or German.

Third Year's Studies.

1. Anatomy.
2. Physiology.
3. * Logic and Psychology, or English Language and Literature.

Explanation of the Course.

Physics. The course in Physics is the same as the minor course (see p. 118,) required to be taken up by candidates who present this subject as one of those in which they desire to graduate.

Chemistry. The course is the same as the major course for the B. A. degree (see p. 118,) except that somewhat less practice in quantitative analysis is demanded.

Biology. The amount of study required is the same as that for the major course (see p. 118).

English Prose Style. The course in English Prose Style will comprise an examination of the style of one or more characteristic English authors, together with exercises in paraphrasing and original composition. One hour a week will be spent in class-room work, and at least another hour will be required for preparation.

Drawing. Sufficient skill to enable the student to represent anatomical and histological specimens.

Logic and Psychology, English. The amount of study required is that represented by the regular collegiate minor courses in those subjects (see p. 118).

Field Club Excursions. All members of the University are eligible as members of the Baltimore Naturalists' Field Club. Non-matriculated students taking the course antecedent to medical studies are required during their two years of biological study to go on the excursions of the Club—and to each is especially allotted some one group of animals and plants, for collecting, preserving and arranging which he is, under guidance, responsible.

Note.

Students who clear off at the entrance examination the French and German demanded, or who for any other reason have time to spare, may take up full major courses in Chemistry and Physics, or may enter any other of the University classes on proving their fitness to the satisfaction of the instructors.

III. SPECIAL STUDENTS.

Young men of collegiate age, who can satisfy a committee consisting of the President and two of the chief instructors that they are sufficiently advanced in character and attainments to be allowed the privilege, and that there is some good reason why they should not offer themselves for matriculation, may be admitted to certain classes; but this privilege is liable to be forfeited at any time, provided the committee is satisfied that there is sufficient reason for its withdrawal.

Students attending the medical schools at present established in the city may thus occasionally obtain permission to attend the courses in Physics, Chemistry, or Physiology, and have the advantage of instruction in the Laboratories of the University. Such students are not, however, entitled to be enrolled as members of the University.

---

* For the subjects under 3, any other of the minor courses taken by candidates for the B. A. degree may be substituted, provided the instructors find the student fit to profit by them.

Scientific Periodicals Published under the Auspices of the Johns Hopkins University.

I.

AMERICAN JOURNAL OF MATHEMATICS.

Professor J. J. Sylvester, F. R. S., D. C. L., Editor in Chief; W. E. Story, Ph. D., Associate Editor in charge. Quarto. Quarterly. Subscription $5.00 per year.

Vol. i. 1878. 388 pp. 4°. 4 plates.
Vol. ii. 1879. 404 pp. 4°. 3 plates.
Vol. iii. 1880. In progress. Three numbers printed.

II.

AMERICAN CHEMICAL JOURNAL.

Professor I. Remsen, M. D., Ph. D., Editor. Octavo. Bi-monthly. Subscription $3.00 per year.

Vol. i. 1879. 460 pp. 8°.
Vol. ii. 1880. 456 pp. 8°.
Vol. iii. 1881. In progress.

III.

THE AMERICAN JOURNAL OF PHILOLOGY.

Professor B. L. Gildersleeve, Ph. D., LL. D., Editor. Octavo. Quarterly. Subscription $3.00 per year.

Vol. i. 1880. 520 pp. 8°.
Vol. ii. 1881. In progress.

IV.

STUDIES FROM THE BIOLOGICAL LABORATORY.

Professor H. N. Martin, Dr. Sc., Editor, and W. K. Brooks, Ph. D., Associate Editor. Octavo. Price $5.00 per volume.

Vol. i. 1879–80. 500 pp. 8°. 40 plates.
Vol. ii. 1881. In preparation.

This includes contributions from the University to various Biological journals, and also the papers independently printed as the "Results of the Chesapeake Zoölogical Laboratory."

As a considerable proportion of the contents of the Studies consists of reprints from the Journal of Physiology, subscribers to the latter may obtain the "Studies from the Biological Laboratory" for $3.50 per volume.

V.

THE JOURNAL OF PHYSIOLOGY.

Michael Foster, M. D., F. R. S., Cambridge, England, Editor in Chief. Octavo. Six parts will form a volume of about 500 pp. Subscription $5.00 per volume.

Vol i. 1878–79. 626 pp. 8°. 17 plates.
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Vol. iii. 1880–81. In progress.

This Journal will in future be published in America with the aid of the Johns Hopkins University, and will be issued from the University to subscribers.

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CALENDAR.

—May 7.	**M. Rabillon's Lectures on French Literature.**
1—April 11.	**Professor McCrady's Lectures on the Theory of Development.**
-18.	**Spring Recess.**
	Session of Marine Laboratory at Beaufort Begins.
.	**Examinations for Matriculation.**
	Present Term of Instruction Closes.
er 20.	**Sixth Academic Year Begins.**
er 21-24.	**Examinations for Matriculation.**
er 27.	**Instructions Resumed.**

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MEETINGS OF SOCIETIES.

tific. First Wednesday of each month, . Next meeting, May 4.

L. B. Fletcher, Secretary.

logical. First Friday of each month, Next meeting, May 6.

M. Warren, Secretary.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, April 12.

Allan Marquand, Secretary.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, April 15.

H. B. Adams, Secretary.

Mathematical. Third Wednesday of each month, at 8 P. M. Next meeting, April 13.

O. H. Mitchell, Secretary.

Naturalists' Field Club. Excursions each Saturday during the Spring and Autumn. Regular meetings for the reading and discussion of papers once a month.

E. M. Hartwell, Secretary.

ENUMERATION OF CLASSES, SECOND HALF-YEAR, 1880-81.

Mathematics. (26 Students).

Classes meet in Room 16.

Theory of Numbers: Professor Sylvester. Twice weekly, Tuesday and Friday, 1 P. M. (5).

Franklin.
Ladd.
Mitchell.
Prentiss.
Van Velzer.

Mathematical Seminary: Professor Sylvester and Dr. Story. Third Wednesday of each month, 8 P. M. (16).

Bissing.
Bland.
Cuykendall.
Davis.
Franklin.
Gilman.
Hathaway.
Ladd.
Matz.
Miller, J. H.
Mitchell.
Norwood.
Perry.
Pickle.
Prentiss.
Van Velzer.

Problems in Mathematics: Dr. Story. Once weekly, Thursday, 12 M. (4).

Bissing.
Matz.
Norwood.
Prentiss.

Higher Plane Curves: *Advanced Course:* Dr. Story. Twice weekly, Tuesday and Friday, 12 M. (5).

Ladd.
Matz.
Mitchell.
Norwood.
Prentiss.

Higher Plane Curves: *Elementary Course:* Dr. Story. Three times weekly, Tuesday, Wednesday and Friday, 11 A. M. (8).

Brown.
Matz.
Perry.

Solid Analytic Geometry: Dr. Story. Four times weekly, Monday, Tuesday, Thursday and Friday, 10 A. M. (5).

Brown.
Davis.
Gilman.
Matz.
Perry.

Conics: Dr. Story. Three times weekly, Monday, Wednesday and Friday, 1 P. M. (8).

Cuykendall.
Davis.
Day, W. C.
Garthe.
Keeler.
Liebig.
Matz.
Reese, C. L.

Mechanics: Dr. Story. Twice weekly, Monday and Thursday, 11 A. M. (6).

Bissing.
Matz.
Mitchell.
Norwood.
Perry.
Van Velzer.

Partial Differential Equations: Dr. Craig. Twice weekly, Wednesday and Friday, 4 P. M. (5).

Bissing.
Mitchell.
Perry.
Prentiss.
Van Velzer.

Modern Algebra: Dr. Franklin. Twice weekly, Monday and Wednesday, 10 A. M. (6).

Bissing.
Matz.
Mitchell.
Norwood.
Perry.
Van Velzer.

Integral Calculus: Dr. Franklin. Three times weekly, Monday, Wednesday and Friday, 11 A. M. (5).

Cuykendall.
Gilman.
Harlan.
Page.
Pickle.

Theory of Equations: Dr. Franklin. Twice weekly, Tuesday, 11 A. M., Thursday, 10 A. M. (2).

Cuykendall.
Reese, C. L.

Differential Equations: Dr. Franklin. Three times weekly, Monday, Wednesday and Friday, 8 P. M. (4).

Freeman.
Koyl.
Matz.
Perry.

Physics. (27 Students).

Classes meet in Rooms 3, 4, 7, 8.

Electricity and Magnetism: Professor Rowland. Four times weekly, Monday, Tuesday, Wednesday and Friday, 11 A. M. (3).

Freeman.
Koyl.
Perry.

Laboratory Work: Professor Rowland. Daily. (3 advanced students).

Fletcher.
Freeman.
Koyl.

Hydrodynamics: Dr. Craig. Four times weekly, Mond
Wednesday and Friday, 8 P. M.; Saturday, 11 A. M. (3).

Bissing.
Perry.
Prentiss.

General Physics: Dr. Hastings. Daily, except Saturday,
A. M. (14).

Adkins.
Berry.
Boston.
Broun.
Day, D. T.
Earle.
Ebeling.
Ingle.
Johnson.
Page.
Robinson.
Stratton.
Tiffany.
Wiegand

Major Course: Dr. Hastings. Lectures once weekly, Thursd
1 P. M.; Laboratory work during week, especially Wednesday. (

Bissing.
Coale.
Cuykendall.
Day, W. C.
Liebig.
Matz.
Mitchell.
Pickle.
Prentiss.

Laboratory Work: (*Class in General Physics*). Dr. Ha
Once weekly, Tuesday. (8).

Boston.
Broun.
Day, D. T.
Earle.
Noyes.
Page.
Stratton.
Wiegand.

Chemistry. (35 Students).

Classes meet in Chemical Laboratory.

Laboratory Work: Professor Remsen and Dr. Morse. Dai
except Saturday. (31).

Baden.
Bayley.
Broun.
Coale.
Cooke, C. A.
Day, D. T.
Day, W. C.
Dosh.
Earle.
Frick.
Garthe.
Harlan.
Keeler.
Keyser.
Kimball.
Kuhara.
Liebig.
Mahon, O. L.
Marburg.
Noyes.
Palmer, A. G.
Palmer, C.
Pickle.
Price.
Pund.
Stevens.
Stokes.
Stratton.
Thomas.
Trimble.
Wiegand.

Chemistry of Carbon Compounds: Professor Remsi
Four times weekly, Tuesday, Wednesday, Thursday and Frid
9 A. M. (12).

Day, W. C.
Donaldson.
Dosh.
Freeman.
Keyser.
Matz.
Noyes.
Palmer, A. G.
Price.
Stevens.
Thomas.
Trimble.

General Chemistry: *Metals:* Dr. Morse. Daily, except Sat
day, 9 A. M. (14).

Baden.
Bayley.
Cooke, C. A.
Earle.
Garthe.
Harlan.
Keeler.
Kimball.
Liebig.
Mahon, O. L.
Marburg.
Stratton.
Warren, H. C.
Wiegand,

Biology. (28 Students).

Classes meet in Biological Laboratory and Lecture Room.

Animal Physiology: Professor Martin. Thrice weekly, M
day, Wednesday and Friday, 11 A. M. (14).

Donaldson.
Dosh.
Hartwell.
Howell.
Keyser.
Lockwood.
Milroy.
Moale.
Reid.
Rolando.
Schimper.
Shippen.
Warfield.
Wilson, E. B.

General Biology: Professor Martin. Thrice weekly, Tuesd
Thursday and Saturday, 11 A. M. (6).

Moale.
Reid.
Schimper.
Stevens.
Trimble.
Warfield.

Comparative Osteology: Dr. Brooks. Daily, except Saturd
10 A. M. (5).

Donaldson.
Reid.
Stevens.
Trimble.
Warfield.

Physiology of the Voice; Embryology of Organs: I
Sewall. Once weekly, Monday, 4.15 P. M. (8).

Donaldson.
Dosh.
Howell.
Keyser.
Milroy.
Reid.
Rolando.
Warfield.

boratory Work: Professor Martin, Dr. Sewall and Mr. Sedgwick. Daily, except Saturday, 9 A. M. to 5 P. M. (28).

Barton.
Clark, B.
Clarke, S. F.
Donaldson.
Dosh.
Fitzgerald.
Hartwell.
Howell.
Keyser.
Le Van Bender.
Lockwood.
Milroy.
Mitsukuri.
Moale.
Reid.
Rolando.
Schimper.
Shippen.
Sternberg.
Stevens.
Trimble.
Warfield.
Wilson, E. B.

ructural Botany: Mr. Sedgwick. This course will begin in April.

getable Physiology: Dr. Schimper. This course will begin n May.

eek. (28 Students).

reek Seminary: Professor Gildersleeve. Thrice weekly, Monday, Wednesday and Thursday, 12 M., Room 13. (13).

Alexander.
Bevier.
Burgess.
Cooke, F. H.
Fleming.
Gjellum.
Harding.
Nicolassen.
Seelye.
Short.
Spieker.
Tidball, C. M.
Tidball, W. J.

ctures on Grammar: Professor Gildersleeve. Twice weekly, Tuesday and Friday, 10 A. M., Room 13. (16).

Alexander.
Bevier.
Burgess.
Cheek, S. R.
Cooke, F. H.
Fleming.
Gjellum.
Harding.
Nicolassen.
Sale.
Seelye.
Short.
Spieker.
Tidball. C. M.
Tidball, W. J.
Treadwell.

ucydides: Professor C. D. Morris. Four times weekly, Monday, Wednesday, Thursday and Friday, 9 A. M., 187 North Howard Street. (4).

Gordon.
Ingle.
Patterson.
Tiffany.

ripides: *Alcestis, Hippolytus:* Professor C. D. Morris. Four times weekly, Monday, Wednesday, Thursday and Friday, 10 A. M., 187 North Howard Street. (6).

Baden.
Canfield.
Crowe.
Glenn, W. L.
Gittings.
Miller, C. W. E.

eek Prose Composition: Professor C. D. Morris.

lass A. Once weekly, Tuesday, 9 A. M., 187 North Howard Street. (5).

Fleming.
Gordon.
Harding.
Ingle.
Tiffany.

lass B. Once weekly, Tuesday, 10 A. M., 187 North Howard Street. (6).

Baden.
Canfield.
Crowe.
Glenn, W. L.
Gittings.
Miller, C. W. E.

w Testament Greek, etc: Mr. Cross. Eight meetings weekly, Monday, Tuesday, Wednesday, Friday and Saturday, 11 A. M.; Tuesday, Wednesday and Friday, 10 A. M., Room G. (2).

Beadenkopf.
Read.

ttendance on Saturday lecture. (14).

in. (32 Students).

Classes meet at 187 North Howard Street.

rence: Dr. Warren. Once weekly, Wednesday, 4 P. M. (12).

Bevier.
Burgess.
Cheek, S. R.
Derby.
Fleming.
Fowler.
Gjellum.
Harding.
Nicolassen.
Sale.
Spieker.
Tidball, C. M.

tin Rhetoricians: Dr. Warren. Once weekly, Monday, 4 P. M. (10).

Alexander.
Bevier.
Burgess.
Cheek, S. R.
Derby.
Fleming.
Gjellum.
Harding.
Nicolassen.
Spieker.

Cicero: *Letters;* ***Pliny:*** *Letters;* ***Juvenal:*** *Satires:* Dr. Warren: Four times weekly, Tuesday, Wednesday, Thursday and Friday, 11 A. M. (11).

Adkins.
Cheek, S. R.
Fleming.
Gordon.
Glenn, W. L.
Ingle.
Kimball.
Miller, C. W. E.
Patterson.
Sale.
Tiffany.

Latin Composition and Translation: Dr. Warren. Once weekly, Monday, 11 A. M. (8).

Adkins.
Cheek, S. R.
Gordon.
Glenn, W. L.
Ingle.
Kimball.
Miller, C. W. E.
Tiffany.

Horace: Mr. Stockbridge. Four times weekly, Tuesday, Wednesday, Thursday and Friday, 9 A. M. (11).

Boston.
Canfield.
Crisp.
Cromwell.
Duffy.
Fels.
Glenn, J.
Jones.
Murray.
Reese, C. L.
Wilson, H. V.

Latin Prose Composition: Mr. Stockbridge. Once weekly, Monday, 9 A. M. (10).

Boston.
Canfield.
Crisp.
Cromwell.
Duffy.
Fels.
Glenn, J.
Jones.
Reese, C. L.
Wilson, H. V.

German. (36 Students).

Old High German: Mr. Brandt. Twice weekly, Tuesday and Friday, 4 P. M., Room A. (2).

Bright.
Fowler.

Middle High German: *Nibelungenlied:* Mr. Brandt. Twice weekly, Thursday and Friday, 11 A. M., Room A. (11).

Berry.
Bowdoin.
Brinton.
Day, D. T.
Ebeling.
France.
Garthe.
Johnson.
Keeler.
Reese, R. M.
Wilson, H. V.

German Seminary: Mr. Brandt. Once weekly, Saturday, 9 A. M., Room A. (12).

Alexander.
Berry.
Bowdoin.
Bright.
Brinton.
Ebeling.
France.
Garthe.
Johnson.
Reese, R. M.
Wilhelm.
Wilson, H. V.

German Ballads: Mr. Brandt. Once weekly, Tuesday, 11 A. M., Room A. (9).

Berry.
Bowdoin.
Brinton.
France.
Garthe.
Gerke.
Johnson.
Reese, R. M.
Wilson, H. V.

German Prose Composition: Mr. Brandt.

Class A. Once weekly, Monday, 11 A. M., Room A. (11).

Alexander.
Berry.
Bowdoin.
Brinton.
Ebeling.
France.
Garthe.
Johnson.
Keeler.
Reese, R. M.
Wilson, H. V.

Class B. Once weekly, Wednesday, 12 M., Room A. (17).

Adkins.
Boston.
Brown.
Crisp.
Duffy.
Fels.
Frick.
Glenn, J.
Jones.
Murray.
Palmer, A. G.
Pickle.
Price.
Stratton.
Thach.
Thomas.
Trimble.

Gryphius: *Peter Squentz:* Mr. Stockbridge. Once weekly, Wednesday, 11 A. M., Room A. (January–March). (9).

Berry.
Bowdoin.
Brinton.
France.
Garthe.
Johnson.
Keeler.
Reese, R. M.
Wilson, H. V.

Goethe: *Faust:* Mr. Stockbridge. Once weekly, Wednesday, 11 A. M., Room A. (10).

Berry.
Bowdoin.
Brinton.
France.
Garthe.
Gerke.
Johnson.
Keeler.
Reese, R. M.
Wilson, H. V.

Goethe: Prosa: Mr. Stockbridge. Twice weekly, Monday and Thursday, 12 M., Room A. (15).

Boston.
Brown.
Crisp.
Duffy.
Fels.
Frick.
Gittings.
Glenn, J.
Jones.
Murray.
Palmer, A. G.
Price.
Stratton.
Thach.
Thomas.

Helmholtz: Populäre Wissenschaftliche Vorträge: Mr. Stockbridge. Twice weekly, Tuesday and Friday, 12 M., Room A. (20).

Adkins.
Boston.
Brown.
Crisp.
Duffy.
Fels.
Fleming.
Frick.
Gittings.
Glenn, J.
Harding.
Jones.
Murray.
Palmer, A. G.
Pickle.
Price.
Stratton.
Thach.
Thomas.
Trimble.

Romance Languages. (24 Students).

Spanish: Mr. Elliott. Twice weekly, Monday and Wednesday, 12 M., Room C. (5).

Baden.
Brinton.
O'Connor.
Reese, R. M.
Taylor, P. H.

Portuguese: Mr. Elliott. Once weekly, Friday, 4 P. M., Room C. (3).

Fay.
Garner.
O'Connor.

Provençal: Mr. Elliott. Twice weekly, Monday, 11 A. M.; Friday, 3 P. M., Room C. (3).

Fay.
Garner.
O'Connor.

Low Latin: Mr. Elliott. Once weekly, Friday, 5 P. M., Room C. (3).

Fay.
Garner.
O'Connor.

French Phonetics: Mr. Elliott. Once weekly, Tuesday, 10 A. M., Room C. (6).

Baden.
Bright.
Garner.
O'Connor.
Reese, R. M.
Taylor, P. H.

French: Major Course: Mr. Marcou. Three times weekly, Tuesday, Thursday and Friday, 12 M., Room B. (3).

Gordon.
Reese, R. M.
Taylor, P. H.

French: Minor: Mr. Marcou. Daily, except Saturday, 1 P. M., Room B. (12).

Bowdoin.
Brown.
Crisp.
France.
Gerke.
Glenn, W. L.
Gordon.
Miller, C. W. E.
Mahon, O. L.
Ramage, B. B.
Ramage, B. J.
Wilson, H. V.

French: Reading Class: Mr. Marcou. Once weekly, Thursday, 3 P. M., Room B. (5).

Beadenkopf.
Boston.
Canfield.
Duffy.
Wiegand.

English. (17 Students).

Anglo-Saxon: Mr. Cook. Thrice weekly, Monday, Wednesday and Friday, 10 A. M., Room A. (7).

Bemis.
Boyle.
Brinton.
Gordon.
Jameson.
MacClintock.
Ramage, B. J.

This class will take up the study of Anglo-Saxon Laws in April.

Anglo-Saxon Poetry: Mr. Cook. Twice weekly, Monday, 12 M.; Wednesday, 4 P. M., 123 West Madison Street. (1).

Bright.

Historical English Grammar: Mr. Cook. Once weekly, Friday, 4 P. M., 187 North Howard Street. (2).

Cheek, S. R.
MacClintock.

Chaucer: Mr. Cook. Four times weekly, Tuesday, Wednesday, Thursday and Friday, 3 P. M., Room B. (6).

Armstrong.
Boyle.
Cheek, F. J.
Cheek, S. R.
Day, D. T.
MacClintock.

General English Literature: Mr. Cook. Once weekly, Monday, 3 P. M., Room B. (9).

Boyle.
Cheek, F. J.
Cheek, S. R.
Day, D. T.
Evans.
Johnson.
Leftwich.
MacClintock.
Reese, R. M.

History of English Language: Mr. Cook. Four weekly, Tuesday, Wednesday, Thursday and Friday, 3 P. Room B. (6).

Armstrong.
Boyle.
Cheek, F. J.
Cheek, S. R.
Day, D. T.
MacClintock.

Icelandic: Mr. Cook. Once weekly, Thursday, 11 A. M., West Madison Street. (Until March). (2).

Bright.
Gjellum.

History and Political Science. (30 Students).

Comparative Constitutional History: Dr. H. B. Ad Once weekly, Saturday, 12 M., Peabody Institute. (17).

Bemis.
Brinton.
Cheek, F. J.
Derby.
Douglas.
Evans.
Goodman.
Jameson.
Johnson.
Linthicum.
McIlwaine.
Ramage, B. B.
Ramage, B. J.
Sale.
Stebbins.
Swift.
Wilhelm.

English Constitutional History: Dr. H. B. Adams. (weekly, Wednesday, 12 M., Peabody Institute. (11).

Bemis.
Berry.
Crowe.
Derby.
Fels.
France.
Ingle.
Jameson.
Ramage, B. B.
Ramage, B. J.
Tiffany.

International Law: Dr. H. B. Adams. Four times we Monday, Tuesday, Thursday and Friday, 4 P. M., Room A. (

Adkins.
Bemis.
Berry.
Bowdoin.
Brinton.
Cheek, F. J.
Ebeling.
Evans.
Fels.
France.
Gordon.
Ingle.
Jameson.
Johnson.
Leftwich.
McIlwaine.
Murray.
Ramage, B. B.
Ramage, B. J.
Robinson.
Sale.
Stebbins.
Tiffany.
Wilhelm.

Logic. (9 Students).

Advanced Logic: Mr. Peirce. Four times weekly, Mon Tuesday, Thursday and Friday, 9 A. M., Room C. (6).

Bissing.
Davis.
Gilman.
Ladd.
Marquand.
Stebbins.

Elementary Logic: Mr. Peirce. Once weekly, Wedne 9 A. M., Room C. (3).

Robinson.
Short.
Wilhelm.

History of Philosophy, and Ethics. (14 Stude

German Philosophy: Professor G. S. Morris. Thrice wee Monday, Tuesday and Thursday, 12 M., 187 North Howard St (13).

Beadenkopf.
Bemis.
Brinton.
Burt.
Crowe.
Howell.
Leftwich.
McIlwaine.
Read.
Robinson.
Stebbins.
Swift.
Wilhelm.

Aristotle's Ethics: Professor G. S. Morris. Once wee Wednesday, 8 P. M., 187 North Howard street. (4).

Burt.
Marquand.
Stebbins.
Swift.

Drawing. (10 Students).

Mr. Newell. Twice weekly, Monday and Friday, 2–4 P. Room 18.

Bond.
Earle.
Frick.
Glenn, J.
Marburg.
Price.
Reid.
Stratton.
Thomas.
Warfield.

Elocution. (15 Students).

Mr. Woodworth. Daily, 9 A. M., Hopkins Hall.

Bemis.
Davis.
Duffy.
Fels.
France.
Gjellum.
Johnson.
MacClintock.
Mahon, O. L.
Mitchell.
Murray.
O'Connor.
Sale.
Schimper.
Seelye.

HOURS	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.	SATURDAY.
A. M. 9	Chemistry. (Remsen and Morse.) Thucydides. (C. D. Morris.) Latin Prose. (Stockbridge.) Logic: Advanced. (Peirce.) Elocution. (Woodworth.)	Chemistry. (Remsen and Morse.) Greek Prose. (C. D. Morris.) Horace. (Stockbridge.) Logic: Advanced. (Peirce.) Elocution. (Woodworth.)	Chemistry. (Remsen and Morse.) Thucydides. (C. D. Morris.) Horace. (Stockbridge.) Logic: Elementary. (Peirce.) Physics: Major. Laboratory work, 9 A. M. to 5 P. M. (Hastings.) Elocution. (Woodworth.)	Chemistry. (Remsen and Morse.) Thucydides. (C. D. Morris.) Horace. (Stockbridge.) Logic: Advanced. (Peirce.) Elocution. (Woodworth.)	Chemistry. (Remsen and Morse.) Thucydides. (C. D. Morris.) Horace. (Stockbridge.) Logic: Advanced. (Peirce.) Elocution. (Woodworth.)	German Seminary. (Brandt.)
10	Physics. (Hastings.) Euripides. (C. D. Morris.) Modern Algebra. (Franklin.) Osteology. (Brooks.) Anglo-Saxon. (Cook.) Solid Anal. Geometry. (Story.)	Physics: Experimental Lecture. (Hastings.) Greek Prose. (C. D. Morris.) Osteology. (Brooks.) Greek Grammar. (Gildersleeve.) French Phonetics. (Elliott.) Hebrew. (Cross.) Solid Anal. Geometry. (Story.)	Physics. (Hastings.) Euripides. (C. D. Morris.) Modern Algebra. (Franklin.) Osteology. (Brooks.) Anglo-Saxon. (Cook.) Hebrew. (Cross.)	Physics. (Hastings.) Euripides. (C. D. Morris.) Theory of Equations. (Franklin.) Osteology. (Brooks.) Solid Anal. Geometry. (Story.)	Physics: Experimental Lecture. (Hastings.) Euripides. (C. D. Morris.) Osteology. (Brooks.) Anglo-Saxon. (Cook.) Greek Grammar. (Gildersleeve.) Hebrew. (Cross.) Solid Anal. Geometry. (Story.)	
11	Animal Physiology. (Martin.) German: Major. (Brandt.) Latin Composition. (Warren.) Mechanics. (Story.) Calculus. (Franklin.) New Testament Greek. (Cross.) Provençal. (Elliott.) Electr. & Magnetism. (Rowland.)	General Biology. (Martin.) German: Major. (Brandt.) Cicero. (Warren.) Elem. Higher Pl. Curves. (Story.) Theory of Equations. (Franklin.) New Testament Greek. (Cross.) Physics: Minor. Laboratory work, 11 A. M. to 5 P. M. (Hall.) Electr. & Magnetism. (Rowland.)	Animal Physiology. (Martin.) German: Major. (Stockbridge.) Cicero. (Warren.) Elem. Higher Pl. Curves. (Story.) Calculus. (Franklin.) New Testament Greek. (Cross.) Electr. & Magnetism. (Rowland.)	General Biology. (Martin.) German: Major. (Brandt.) Cicero. (Warren.) Mechanics. (Story.)	Animal Physiology. (Martin.) German: Major. (Brandt.) Cicero. (Warren.) Elem. Higher Pl. Curves. (Story.) Calculus. (Franklin.) New Testament Greek. (Cross.) Electr. & Magnetism. (Rowland.)	General Biology. (Martin.) New Testament Greek. (Cross.)
M. 12	Greek Seminary. (Gildersleeve.) German: Minor. (Stockbridge.) Spanish. (Elliott.) German Philos. (G. S. Morris.)	German: Minor. (Stockbridge.) French: Major. (Marcou.) Adv. Higher Pl. Curves. (Story.) German Philos. (G. S. Morris.)	Greek Seminary. (Gildersleeve.) German: Minor. (Brandt.) Spanish. (Elliott.) Eng. Const. History. (Adams.)	Greek Seminary. (Gildersleeve.) German: Minor. (Stockbridge.) French: Major. (Marcou.) Math. Problems. (Story.) German Philos. (G. S. Morris.)	German: Minor. (Stockbridge.) French: Major. (Marcou.) Adv. Higher Pl. Curves. (Story.)	Comp. Const. History. (Adams.)
P. M. 1	French: Minor. (Marcou.) Conics. (Story.)	French: Minor. (Marcou.) Theory of Numbers. (Sylvester.)	French: Minor. (Marcou.) Conics. (Story.)	French: Minor. (Marcou.) Physics: Major. (Hastings.)	French: Minor. (Marcou.) Conics. (Story.) Theory of Numbers. (Sylvester.)	
2	Drawing. (Newell.)				Drawing. (Newell.)	
3	Gen. English Lit. (Cook.) Hydrodynamics. (Craig.) Diff. Equations. (Franklin.)	Chaucer. (Cook.)	Chaucer. (Cook.) Hydrodynamics. (Craig.) Diff. Equations. (Franklin.)	Chaucer. (Cook.) French: Reading Class. (Marcou.)	Chaucer. (Cook.) Provençal. (Elliott.) Hydrodynamics. (Craig.) Diff. Equations. (Franklin.)	
4	Internat. Law. (Adams.) Latin Rhetoricians. (Warren.) Physiology of the Voice. (Sewall.)	Internat. Law. (Adams.) Old High German. (Brandt.)	Part. Diff. Equations. (Craig.) Terence. (Warren.)	Internat. Law. (Adams.)	Internat. Law. (Adams.) Part. Diff. Equations. (Craig.) Old High German. (Brandt.) Portuguese. (Elliott) Hist. English Gram. (Cook.)	
5			Ethics. (G. S. Morris, 8 P. M.)		Low Latin. (Elliott.)	

The public lectures in Hopkins Hall begin at 5 P. M.

(March 28, 1881.

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

Published here.

American Chemical Journal. Edited by **Professor Remsen.** *Vol. II.* *No.* 6. February, 1881.

Article I.—On a Simple Form of Apparatus for Determining the Specific Heat of Solids and Liquids with small Quantities of Material. By J. W. **Mallet.**

The forms of apparatus most in use for the determination of specific heat—those of Regnault and Bunsen—are somewhat troublesome to prepare. The Author describes in this paper a simple form, easily constructed, and giving good results. No adequate idea of the apparatus can be given without the aid of the four detailed drawings which accompany the article.

Article II.—On Jarosite from a new Locality. By G. A. **König.**

The material used in this investigation was collected by the Author in a "prospect" for carbonates in porphyry, in Chaffee county, Colorado. The jarosite itself, $K_2Fe_6S_4O_{22} + 6H_2O$, is mixed with some thurgite $Fe_4H_2O_7$.

Article III.—On Beegerite, a new Mineral. By G. A. **König.**

This mineral was found to have the empirical formula $Pb_6Bi_2S_9 = 6PbS + Bi_2S_3$. It occurs in the Baltic Lode of the Geneva Mining Company, Park county, Colorado.

Article IV.—Researches on the Substituted Benzyl Compounds:—The Synthesis of Anthracene and Phenanthrene from Orthobrombenzylbromide. By C. L. **Jackson** and J. **Fleming White.**

While it has been known for some time that anthracene consists of two benzene residues united by means of two—$\underset{|}{CH}$—groups, it was not known whether the union is effected in the ortho, meta or para- position. The synthesis here described shows clearly that the hydrocarbon is an ortho-compound. The synthesis was effected by treating orthobrombenzylbromide, $C_6H_4Br.CH_2Br$ in an ethereal solution with sodium. Phenanthrene is also formed at the same time.

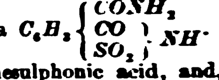
Article V.—On Sauer's Method of Estimating Sulphur, and some Modifications. By W. G. **Mixter.**

Article VI.—The Determination of Sulphur in Sulphides and in Coal and Coke. By T. M. **Drown.**

The method employed and here described consists in treating the substance to be analyzed with sodium hydrate in a beaker, then adding bromine cautiously to supersaturation, and finally hydrochloric acid to acid reaction. This method is found to be especially valuable in the analysis of coal.

Article VII.—On the Oxidation of Substitution Products of Aromatic Hydrocarbons:—Sulphoterephthalic acid. By **Ira Remsen** and W. **Burney.**

The acid was obtained by oxidizing cymenesulphamide, first with potassium pyrochromate, and the sulphamineparatoluic acid thus obtained, with potassium permanganate. Its tribasic character was proved by the preparation of three well characterized barium salts the compositions of which correspond to those required for the primary, secondary and tertiary salts. It yields a sulphinide of the formula



$C_6H_3\left\{\begin{array}{l}CONH_2\\ \left.\begin{array}{l}CO\\ SO_2\end{array}\right\}NH\end{array}\right.$

The acid was also prepared by oxidizing cymenesulphonic acid, and, thus obtained, it has the same properties as that obtained as above described.

Article VIII.—Sulphoterephthalic acid from Paraxylenesulphonic acid. By **Ira Remsen** and M. **Kuhara.**

To verify the results reached in the investigation described in the preceding paper the sulphonic acid of pure paraxylene was oxidized. By first converting into sulphotoluic acid and then oxidizing the latter with potassium permanganate, sulphoterephthalic acid was obtained.

Brief Review of the most important changes in the Industrial Applications of Chemistry within the last few years, (continued). By J. W. **Mallet.**

The subjects taken up in this report come under the general heading—"Materials and Processes connected with the Construction of Buildings," The subheadings are: *Chief Building Materials for External Use: Stone and Brick; Lime-burning, Mortar and Hydraulic Cements; Stucco; Preservation of Timber; Glue and other Cements of various application; Pigments for House-Painters' use; Vehicles for Paints; Varnishes:* and in an "Appendix to Building Appliances" there are: A. *Explosive Agents;* B. *Disinfectants.*

Recent Progress in Agricultural Science. By H. P. **Armsby.**

The subjects treated are: *Metastasis; Proteid Metastasis.*

Then follow Notes on: *Properties of Ozone*, by Hautefeuille and Chappuis; *New Ethers of Carbonic acid*, by Röse; *The Atomic Weight of Glucinum*, by Nilson; *Synthesis of Tropic acid*, by Ladenburg and Rügheimer; *The Hydrocarbons of American Petroleum*, by Beilstein and Kurbatow; *Concerning the Formula of Benzene*, by Julius Thomsen; *Arsinobenzoic acid*, by La Coste; *Baeyer's Method for the Synthesis of Indigo; Brevities; List of New Publications.*

The Number closes with the Index completing the Volume of 448 pages.

The first Number of Volume III of the American Chemical Journal is nearly ready. It contains original communications by J. W. Mallet, S. P. Sadtler, C. L. Jackson, H. B. Hill, E. J. Hallock, M. Kuhara, M. W. Iles, and R. B. Warder.

THE AMERICAN JOURNAL OF PHILOLOGY.

Announcement of Volume II, by the Editor.

The American Journal of Philology is about to enter upon its second volume. The experiment of the first year has been so far successful as to warrant a continuance of the enterprise and it is hoped that a widening support will enable the Editor and those who are associated with him to make the Journal a more and more adequate representative of the philological life of America, and an efficient organ for the promotion of philological research and study. There is every prospect of an ample supply of original papers for the new volume. The first number will contain the sequel of Professor Nettleship's valuable paper on Verrius Flaccus, a study of Bentley's English by Professor Shepherd, the first part of an elaborate essay on the consonant declension in Old Norse by Dr. S. Primer and an article on *-ne* in Latin by Dr. Minton Warren. For the second number an essay on the revision of King James's version has been prepared by Professor Charles Short, one of the American revisers. Reviews will as heretofore be intrusted, as far as possible, to specialists, and any expansion that the success of the Journal may admit will be largely in this direction. The reports of Periodicals, which have proved so acceptable a feature, will be kept up and most of the scholars who have undertaken this task—which requires so much knowledge, judgment and tact—have kindly consented to continue their help and new forces have been added. The Bibliography, which is intended to comprise all important publications of the time, will also continue to be a regular department of the Journal. For the general management the Editor is of course responsible, but he has the great advantage of advice and help not only from his own colleagues but from philological friends on both sides of the water, and in the department of general philology and comparative grammar he is permitted to count on the aid of Professor Whitney, who has generously given to the Journal his counsel and his personal work. From the beginning the oriental department has been in charge of Professor Toy and the Anglo-Saxon in that of Professor Garnett, and these scholars will continue to lend their valuable assistance.

With a better organization and a clearer view of the capabilities of the field, the Editor enters upon the work of the new year with a more reasonable confidence that the Journal is destined to a usefulness commensurate with the expectations of those who generously made the undertaking possible.

The price of the Journal is unchanged, $3 a volume—of four numbers—payable to the Editor in advance. The first volume contains 536 pp. with a full index.

B. L. **Gildersleeve.**

NOTES FROM THE BIOLOGICAL LABORATORY.

No. 2.*

A Study of Blood Pressure in the Coronary Arteries of the Heart. By H. Newell Martin and W. T. Sedgwick.

The great anatomist Thebesius, (*Diss. med. inaug. de circ. sang. in corde*, 1708,) propounded the theory that the flaps of the semilunar valve of the aorta are pressed against the wall of that vessel during the systole of the heart, and occlude the mouths of the coronary arteries which lie behind them. This view fell into oblivion until it was revived and powerfully supported in recent times by Brücke. The reasoning of the latter is largely teleological; since the heart is a hollow structure which diminishes its bulk, and, so far as the ventricles are concerned, obliterates its cavity in contraction, he points out that a forcible injection of the heart arteries with blood during the systole of the organ, would tend to make its walls tense and oppose the contraction; while if the coronary arteries received no blood during the ventricular systole but were filled with it during the diastole, the contraction of the heart would not be impeded and its subsequent dilatation would be promoted. Arguing from the general mechanical perfection found in the mammalian body, he concluded that it was probable that the view of Thebesius was correct, and that the semilunar valve flaps were really so placed during the ventricular systole as to prevent blood from entering the proper cardiac arteries; while in diastole the organ had its walls tensely filled with blood and its cavities consequently expanded.

The experimental evidence for and against this view cannot be discussed in this brief article; it will suffice to state that prominent physiologists have been hitherto divided on the question, and experiments and anatomical observations have been published on each side; the result being a general belief that the question could only be definitely settled by an observation of arterial pressure in the coronary vessels; if the coronary pulse coincided with that in other arteries Brücke would be wrong; if it alternated with it, he would be right. The difficulty of introducing a cannula into the arteries of the living beating heart, seems hitherto to have foiled physiological experimenters, and we undertook the task without any very great hopes of success, but induced by the many important points in the physiology of the mammalian heart and the mechanism of the circulation, which would be rendered available for study should we succeed.

Our experiments were made on dogs, placed very completely under the influence of morphia; after a considerable number of failures we have succeeded in getting on seven or eight animals simultaneous graphic records of mean arterial pressure and pulse beats in the carotid and coronary arteries. The results of a careful examination of these are—

1. The blood pressure in the coronary arteries is comparatively very great; being in a small branch very little less than equal to, or greater than that in the carotid trunk.

2. The coronary and carotid pulses are practically synchronous in time; there is no trace whatever of an alternation in them. This holds true whether the arterial pressure be high or low, or the heart's rhythm slow or quick; and every minutest feature of the graphic record in the tracing of blood pressure in the carotid is simultaneously and perfectly repeated in that obtained from the coronary artery. Whether the heart's beat be slowed by stimulation of the cardio-inhibitory nerves, or arterial pressure be greatly raised by inducing dyspnœa, the general and sphygmic variations of pressure in the two arteries are perfectly synchronous and similar in form: the record traced from each artery is in its variations an exact duplicate of that obtained from the other.

The results of these experiments prove that for the dog the Thebesius-Brücke view (with a predilection in whose favor we started) is untenable: although the ventricular systole might be conceived to raise pressure in the coronary artery, it is inconceivable that every minute character of the carotid tracing should be synchronously and perfectly reproduced in that from the coronary artery unless both were due to the same immediate cause, viz: the elevation of arterial pressure in the aorta by the systole of the left ventricle; the mouths of the coronary arteries are therefore not closed by the flaps of the semilunar valve during ventricular systole.

We are now engaged in an examination of the results of stimulation of the accelerator nerves upon the mean pressure in the coronary artery, with the hope of discovering whether these puzzling nerves are not the vasomotor branches controlling the cardiac arteries, but our results on this point are not ready for publication.

A full account of the experiments on which the above statements are based, with reproductions of the tracings obtained, will shortly be published in the Journal of Physiology.

No. 3.

On a Method of Isolating the Mammalian Heart. By H. Newell Martin.

To obtain a mammalian heart isolated from the rest of the body and keep it alive for a time sufficient to allow the examination of the effect of various conditions upon its activity has long been a physiological desideratum. The frog's heart has for years been the subject of minute study but hitherto the mammalian heart has been a baffling object It seems to have been forgotten that while the frog's heart is a spongy structure having no arteries of its own, the mammalian heart is a dense organ dependent for its life on a continuous blood flow in its capillaries; and all attempts hitherto made, so far as I know, have been efforts to apply to the mammal the methods found successful with the frog, with merely the addition of arrangements adapted to keep up the comparatively high temperature at which the mammalian heart normally beats. By working in another way I have recently succeeded in keeping the mammalian heart alive for more than an hour, and beating with perfect rhythm and normal force; the organ is thus made almost as available for study as the heart of the frog. The method adopted is as follows: The animal having been narcotised and the chest opened, the aorta is tied just beyond its arch; then the trunk which, in the cat, gives origin to the right subclavian and the two common carotids, is ligatured close to its origin, and a cannula put in the left subclavian: finally, the inferior and superior venæ cavæ and the azygos vein, and the root of one lung are tied.

Artificial respiration is of course started so soon as the thorax is opened, and kept up henceforth. The course of the circulation is thus:—left auricle, left ventricle, commencement of aorta, (and along the left subclavian to the cannula which is connected with a manometer), coronary system, right auricle, right ventricle, pulmonary vessels of one lung, and then back to the left auricle; in other words, the only section of the systemic circulation left is that through the vessels of the heart itself. Since the physiological actions taking place in the lung are among the best known of all occurring in the body, they may be eliminated, and we have practically an isolated and well-working living mammalian heart for study. The nerves going to the heart may be divided if desired, but that is hardly necessary as the want of blood-flow in the nerve centres of the body incapacitates them after a very short time, and they no longer are capable of exerting any influence on the heart. It is possible, however, that changes in the lung vessels may affect the results of experiments made on the heart's work under different conditions, (*e. g.* when defibrinated blood is sent into it from a vein under various pressures, or when drugs are administered to it), and an investigation of the nerves, if any, governing the lung vessels must be undertaken as a preliminary to a further study of the direct action of various conditions on the heart's work.

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* Note No. 1, on page 51.

PROCEEDINGS OF UNIVERSITY SOCIETIES.

Abstracts of the More Important Papers Read at Recent Meetings.

Scientific Association.

January Meeting.

On the Double Submaximal Stimulation of Muscle and Nerve, by H. Sewall.

This paper embodied a discussion of the nature of "tetanus," as dependent upon a summation of excitements or of contractions. The polarizing effects of very weak induced currents upon the nerves were also considered.

Some Arithmetical Theorems Derived from a Question in Probability, by Fabian Franklin.

From a consideration of the probability that an event, which has occurred in all the trials (say n trials) of a given kind that have been made, will occur in each of the next r trials of the same kind, we obtain the well known theorem $\Sigma_0^r \binom{n+x}{n} = \binom{n+r+1}{n+1}$. If in the n trials the event has occurred λ times and failed $n-\lambda$ times, then by considering the probability that in the next r trials it will occur μ times and fail $r-\mu$ times, we obtain the theorem, which perhaps is new, that $\Sigma_0^r \binom{\lambda+x}{\lambda}\binom{n-\lambda+r-x}{n-\lambda} = \binom{n+r+1}{n+1}$; it is to be observed that the value of the sum is independent of λ. From this equation a theorem relating to the determinants of binomial coefficients immediately follows.

February meeting.

A New Computation of the Compression of the Earth, from Pendulum Experiments, by C. S. Peirce.

The principles adopted were as follows: 1. Only experiments with the Kater invariable pendulum were used 2. These were newly reduced, using the temperature and pressure coefficients determined by the India survey. 3. The continents were considered to be formed by upheaval, so that the usual reduction for continental attraction disappeared In estimating the small residual effect, it was assumed that the thickness of the crust upheaved is $\frac{1}{8}$ of the diameter of the arch which gives $\frac{1}{12}$ of the usual correction. 4. The entire attraction of the ocean has been allowed for. It was shown that the adoption of these principles in the computation greatly reduces the station errors. The resulting compression is $\frac{1}{293.0 \pm 0.5}$.

Some new Experiments on the Oxidation of Sulphaminemetatoluic Acid, by R. D. Coale.

If sulphaminemetatoluic acid be oxidized by potassium permanganate in *neutral* solution, it has been found that the sulphamine group is transformed into the sulpho group, and the product is sulphoisophthalic acid. If, however, this oxidation be carried on in *alkaline* solution, the product belongs to a class of anhydro bodies which have been called sulphinides, and is anhydro-sulphamine-iso-phthalic acid or sulph-inido-iso-phthalic acid. This point is disputed by Jacobsen, and experiments are in progress to definitely settle the matter.

A Spectroscopic Note, by C. S. Hastings.

This paper, with one read at a previous meeting, described a method by which the spectrum of sodium vapor in a Bunsen lamp might appear, in a powerful spectroscope, either as the well known double bright line; as four bright lines and two dark ones; as six bright lines and four dark; or, finally, as eight bright lines and six dark. All but the last named phenomenon had been observed by Young and others. Certain peculiarities occasionally observed in the spectrum of the sun are readily explained in the same manner.

March meeting.

The Cause of Serial Homology and Bilateral Symmetry, by W. K. Brooks.

Owing to the length of this paper, only part of it was read. In this portion the writer attempts to show that the explanation which attributes phenomena of this kind to inheritance from a community of independent individuals which have become specialized into a compound organism, is not supported by the facts of embryology, and that even if it were, this would not account for the phenomena, since they exhibit evidence that the bond between serially homologous structures is persistent.

The phenomena in question cannot, at present, be explained by natural selection, and the view that they are due to the direct action of the conditions of life, or to polarity is also inadequate; and at present we have no explanation of them.

They are so similar to the phenomena of ordinary or special homology, that, so long as they are unexplained, we cannot give unqualified acceptance to the explanation of special homologies, which attributes them to descent with modification.

A New Determination of the Mechanical Equivalent of Heat, by L. B. Fletcher.

This determination was made by measuring the heat developed by a current of measured strength flowing for a measured time through a wire of measured resistance.

The result is $J = 42{,}200{,}000 \left(\frac{\text{centimeter}}{\text{second}}\right)^2$ gram at 25.°8 C, on the assumption that 1 Ohm $= 1 \frac{\text{earth quadrant}}{\text{second}}$.

The mean of Joule's and Rowland's direct measurements gives $J = 41{,}700{,}000 \left(\frac{\text{centimeter}}{\text{second}}\right)^2$ gram at 25.°8 C. The difference between these two values is about 12 parts in 1,000.

The inference is that the Ohm $= .988 \frac{\text{earth-quadrant}}{\text{second}}$ which agrees fairly with the direct measurements of the Ohm by Rowland and Lorenz.

The Structure of the Gills of Yoldia and Nucula, by K. Mitsukuri.

In the ordinary lamellibranchs the gills are extremely complicated structures, which not only perform a respiratory function but also gather food from the water, convey it to the mouth, effect the fertilization of the eggs, and, in some forms, also serve as nursing chambers for the young.

In Nucula and Yoldia the gills are quite simple in structure, and have only a respiratory function. A careful study of their structure indicates that we have in them the primitive form of lamellibranch gill, which has, in most forms, become specialized into the ordinary complex gill.

In these two genera they are much like the gills of gasteropods and cephalopods, and their structure lends support to the view that these forms rather than the lamellibranchs are nearest to the primitive molluscs, and that the gills of ordinary lamellibranchs have gradually assumed nutritive and reproductive functions, as these animals have become adapted to a sedentary life.

Philological Association.

January Meeting.

Final Sentences in the New Testament, by J. M. Cross.

The unsatisfactory treatment of final sentences in the New Testament is the result of a theory that the particles are used indiscriminately without reference to their classical connection or signification, because of ignorance of Greek on the part of the writers. This theory is based, to a

extent, on the Received Text and supported by many isolated pas-
that a critical text now removes. An examination of those which
tained—640 in all—shows, 1st, that, while there is a marked depar-
'rom classical rules in the use of the moods, there is evidence of a
ncy to emphatic statement, which will, in a measure, explain the
ze. After secondary tenses the optative is no longer used, the sub-
ive taking its place in all cases. After primary tenses with ἵνα, the
e indicative, as a more vivid form begins to appear. ὅπως is not used
the future indicative and μή in but few passages. 2d. There is evi-
of selection in the use of the final particles themselves, ὡς having
peared, ὅπως and μή being very much restricted, while ἵνα has been
y extended and has almost absorbed the others. The MS. evidence
l the disputed passages was examined and the explanation offered
e peculiar case of the moods and the extension in the form of ἵνα,
that the former was due to the desire for emphatic and vivid state-
, causing the choice of the subjunctive for the optative, and the
e indicative for the subjunctive; and the latter to the influence of
ew teleology. If this theory is correct, it follows that great care
be exercised in exegesis not to unduly press the signification of the
nctive, as there is no longer any ground for comparison with the
ve; and also, that the telic force of ἵνα is not to be obliterated until
be shown to be contrary to the sense of the passage in which it
rs.

the Negative in Early French, by B. F. O'CONNOR.

particle "*mie*" (*mica*) first appears in French as an adverb in the
gment de l'Alexandre d'Alberic de Besançon," and almost simul-
usly is found joined to the particle "*ne*" as a re-enforcement of the
ive. From this epoch. XIth century, down to XVIth century, about
time it disappears from ordinary use, it is employed in this latter
only.

cause of its being joined to "*ne*" as an essential part of the nega-
s due to the weakening of the negative signification of "*ne*" so
nt in early French writings where this particle is sometimes used
conjunction.

r. A. S. COOK gave an account of a recent Collection of English
ns by Kwong Ki Chiu, late of the Chinese Educational Mission
e United States.

uary meeting.

the Genuineness of the First Antiphontean Oration, by EVIER.

s oration was regarded by Maetzner as a mere rhetorical exercise,
he tetralogies. By others, *e g.* Pahle and Fuhr, it has been declared
us. The arguments advanced by Maetzner in support of his posi-
re not cogent and have been answered in detail by Ottsen. In com-
g the first speech with the others, we find many important differ-
especially from the standpoint of literary criticism Most impor-
f all is the wide divergence in the purpose and management of the
ent parts of the orations. The narrative and arguments of the first
n differ fundamentally in form and relative importance from the
ponding parts of the others Antiphon, as we know him in his
bted works, is subtle and skillful in argument but pays little atten-
o the construction of the narrative In this oration on the other
we find an artistic narrator and bungling logician. Differences may
e noted in tropology, the handling of synonyms and the use of *a*
probability as an engine in argument. A minute examination of the
age itself however reveals some coincidences, *e. g.*, in the use of
'ε, τε — καί, τοῦτο μέν — τοῦτο δέ, the articular infinitive, and certain
hrases, but to counterbalance these, the first oration differs from the
, in the use of τε καί, in not employing the neuter singular of adjec-
and participles as abstracts, in the choice of prepositions both simple
n composition, in the position of the possessive pronouns, and with
d to special words, *e. g.*, μέλλω, compound relatives, etc. Since the
testimony of the form and general style is not weakened but rather
thened by closer linguistic examination, we may reasonably affirm
his oration is not the work of Antiphon.

Certain Locatives in Andocides, by E. S. BURGESS.

locative endings considered were -δε and -ζε, -θεν, -ι, with names
ces. It was shown that in Andocides they occur twice, or more than
, as often proportionately as in any other Attic orator or in Thucy-
Regarding Andocides as a representative of the spoken Attic, their
e in colloquial speech is thus suggested. They became early a marked
e of legal language. They were less stately than the corresponding
prepositional phrases, and occur comparatively seldom in Antiphon or Isocrates, in original sentences of Thucydides or the public orations of Demosthenes.

With Athens the Attic orators generally used the locative ending. Byzantine scholarship condemned any other use, and it has been followed by Liddell and Scott, and others. On the contrary Thucydides uses prepositions with Athens regularly and Demosthenes in Oration 56 frequently.

The earlier orators used the locative endings only with places in or near Attica, or the seats of national games. Demosthenes and his contemporaries failed to maintain this use of the locative with neighboring places but increased the use with Athens. Of examples of locative endings, those with Athens therefore constitute in the earlier orations but a small part, in the later almost the entire number.

The Omission of the Copula in Plautus and Terence, by M WARREN.

A statement was made of the views of Ritschl in regard to the omission of the copula, of the modifications made by Brix, and the objections urged by Ussing. It was shown that Ritschl had too often introduced *est* into the text against the manuscript authority, but that his observation in the main is strongly confirmed by statistical comparisons. In some cases not considered by Brix the omission of the copula may be due to the strong emotion. The use of the phrase *meliust* or *melius est*, received special attention. It is found 39 times in Plautus and 5 times in Terence. *Melius erit* with the Perfect Infinitive, a usage common in Livy, does not occur in Plautus, and is found but once in Terence, Adel. 180. The peculiar diminutive *meliusculumst* occurs Curc. 489. Eleven examples are found of *meliust* followed by *te* with an active Infinitive. Finally 5 examples were cited of *melius* with an active Infinitive where the ground for the omission of the copula may be the same as in Hor. Sat., II 1, 45 *melius non tangere* and Cic. ad Att. XIV, 22 *melius mori milies.*

PROFESSOR GILDERSLEEVE described a terra-cotta jar with three compartments, found by Schliemann at Hissarlik, and offered an explanation of its probable use.

March Meeting.

Dialect Peculiarities of *Richars le Biaus*, by A. M. ELLIOTT.

From a detailed count of the dialect-forms in the *Richars*, this paper was intended to show its leading phonetic characteristics, which, it is held, prove both author and copyist to have been Picard. The statements of Förster and Knauer with reference to certain vowel combinations (*e g.* the diphthongisation of Latin position — $i = ie$, and the traces of the Burgundian *oi*) were found to be incorrect, when the whole body of vocalisation of the poem was carefully considered. and the relations of these phenomena more accurately determined. Examples were drawn from Tobler's *Aniel*, Gaston Paris' *Vie d'Alexis* and from Modern French to illustrate the strong tendencies to Picard diphthongisation manifest throughout the work. The guttural system (both *tenues* and *mediae*) substantiate the results obtained from the vowel-system.

The Limits of New Testament Textual Criticism, by J. M. CROSS.

The arguments for the theory that any text of the New Testament at this day, as *e g.* that determined upon by the Revision Committee, can be a complete and final one, are inconclusive. because: 1. We cannot say that we have all the evidence for establishing the text that we ever shall have New manuscripts may turn up, which would essentially alter the views now held as to the value of special types. 2 The materials we possess have not yet been exhausted, and there is still a great deal of work to be done in the collation of manuscripts and sifting of Patristic quotations. Mistakes of Tischendorf and Tregelles, commented upon, show the need of more careful examination of the sources on which they depend. 3. The application of the same generally accepted principles gives rise to very different results at the hands of different critics. Consequently, any text represents simply the individual judgment of the editor on the evidence before him. and the results reached give us an approximate text only. Textual criticism has reached the limits of its application when it has brought forward all the evidence that is capable of being produced, carefully weighed and accurately stated, so that every one. after a full and free examination, can form his own conclusion on disputed points. The result is not so unsatisfactory, for its value lies in the unanimous evidence which is given for the main portion of the text about which there can be no dispute.

On Certain Compound Determinants, by C. A. Van Velzer.

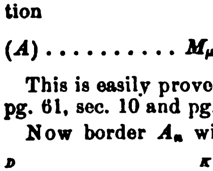
A determinant of order n whose elements are a_{ik} will be designated by A_n, a minor of A_n of order λ by A_λ, the determinant of all minors of A_n of order m by M, and $\frac{r!}{s!\,(r-s)!}$ will be designated by r_s.

If in the determinant A_n we select a minor A_h and form all those minors of order m of A_n $(m < h)$ which are not formed by selecting *entirely* from A_h we form a determinant M_μ of order $n_m - h_m$ which satisfies the equation

$$(A) \ldots\ldots\ldots\ldots M_\mu = A_{n-h}^{(h-1)_{m-1}} \cdot A_n^{(n-1)_{m-1} - (h-1)_{m-1}}.$$

This is easily proved by means of the theorems in Scott's Determinants, pg. 61, sec. 10 and pg. 64, sec. 16.

Now border A_n with $n - h$ rows and columns as in diagram, where the units run perpendicular to the principal diagonal and all other elements in the border are zeros, and where AC represents the determinant, A_n.



It is evident that the whole determinant $AD = AB$, i. e. $= A_h$.

Consider the determinant AD divided by the dotted lines in the figure, so that KL is a square block, say of order k $(< h)$.

If we form an m^{th} minor of AD by striking out m of the rows and columns intersecting in KL, it is plain that this minor reduces to a square block formed by striking out m columns of AB and substituting m columns from GB in their stead.

The determinant of all possible such m^{th} minors is a compound determinant of order k_m whose elements are determinants of order h formed by replacing m columns of AB, which are to the right of the vertical dotted line, by m columns of GB selected from the k columns adjacent to AB.

The determinant of these m^{th} minors is, of course, a minor of the determinant of *all* m^{th} minors of AD, and, as such, we have, designating this minor by M_k,

$$M_k = (AD)^{k_m - (n-1)_{m-1}} \cdot M' = A_h^{k_n - (n-1)_{m-1}} \cdot M'$$

M' denoting the complementary minor in the reciprocal block.

Applying formula A to this case we obtain

$$M_k = A_{n-k}^{(k-1)_{m-1}} \cdot A_h^{(k-1)_m}.$$

A_{n-k} is the square block ML, and evidently reduces to a square block of order h formed by the $h - k$ columns of AB to the left of the dotted line and the k right-hand columns of BG.

Hence the determinant T_h in Scott's Determinants, pg. 68, sec. 14, may, in certain cases, be expressed without reference to the complementary minor in another determinant.

Many other theorems might be deduced by different selections of the square block KL which may be any square block which contains none of the rows and columns intersecting in BC.

On the Prerogative of a Ternary Denominational System of Coinage, by J. J. Sylvester.

Professor Sylvester drew attention to the fact that a system of coinage in which each coin is three times the value of the one below it would possess a superiority *above every other* in so far as it would admit of all payments up to any assigned limit, being effected with the smallest possible number of pieces, this advantage increasing with the size of the limit. Thus suppose the limit of 10 dollars to be selected, two persons each possessed of 7 coins of the respective value of 1, 3, 9, 27, 81, 243, 729 cents could pay each other by interchange of their coins any sum from 1 cent up to this limit. The full amount so capable of being paid being of course, $\frac{3^7 - 1}{2}$ cents, *i. e.* \$10.43. Whereas with 7 coins doubling at each step, the extreme limit would be \$1.27.

Again if each coin were quadruple the value of its antecedent, the extreme limit attainable with 8 coins would be only 2 $(1 + 4 + 16 + 64)$, or \$1.70. The sum of the geometrical progression $1 + 5 + 25 + 125 + 625$ being 781; 10 coins at least would be required to be possessed by each of two persons to enable one of them to pay the other any amount from 1 cent up to \$7.81, whereas as previously shown, 7 would be more than sufficient to allow of this being done on the ternary scale.

Thus the absolutely perfect system of coinage, so far as this depends on the smallness of the number of coins necessary to be used, is that which proceeds in a geometrical progression according to the ternary scale.

The following problem in arithmetic, is suggested by the preceding considerations.

What is the condition that the sums and differences of the integers a_1, a_2, a_3, . . . a_n, not subject to any defined law of progression, may comprise between them all the numbers from 1 up to $a_1 + a_2 + a_3 \ldots + a_n$.

March meeting.

On Binomial Congruences, (mod. $p, f(x)$), by O. H. Mitchell.

If $f(x) = K = A^t B^u C^v \ldots$, where A, B, etc., are functions of x irreducible with respect to a prime modulus, p, and are of degrees a, b, c, respectively, then the number of functions of x, of a less degree than the degree of K, which contain no factor of K with respect to p, being designated by $\tau(K)$, and the number which contain A but no other factor of K being denoted by $\tau_A(K)$, etc. for $\tau_B(K), \ldots \tau_{AB}(K), \ldots \tau_{ABC}(K), \ldots$, the values of these numbers are found from the corresponding numbers for an integer $k = a^t b^u c^v$, by substituting p^a for a, p^b for b, etc. Thus, if $K = A^t B^u C^v$,

$$\begin{array}{rlr}\tau(K) = & p^{(t-1)a} p^{(u-1)b} p^{(v-1)c} & (p^a - 1)(p^b - 1)(p^c - 1), \\ \tau_A(K) = & \text{“} & (\ldots\ldots)(p^b - 1)(p^c - 1), \\ \tau_{AB}(K) = & \text{“} & (\ldots\ldots)(\ldots\ldots)(p^c - 1), \text{ etc.}\end{array}$$

The roots of $X^2 \equiv X$ (mod. p, K) have the same properties as those of $x^2 \equiv x$ mod k. Thus if $i =$ the number of irreducible functions (mod. p) contained in K, there are 2^i roots one belonging to each of the 2^i classes of functions enumerated above. If these roots be designated by R_1, R_A, R_B, . . . R_{AB}, ... , and $s = AB \ldots D$, $s' = FG \ldots L$, then,

$$R_s R_{s'} \equiv R_{ss'} \text{ (mod. } p, K).$$

Also, the sum of any number of these roots is congruous (mod. p, K) to the sum of the same number of any others of them, provided the product of the subscripts is the same for each sum. If $\bar{s}$ denote the product of all the irreducible (mod. p) functions contained in K except those contained in s, then,

$$R_{\bar{s}} R_{\bar{s}'} \equiv 0 \text{ (mod. } p, K),$$

$$R_{\bar{s}} + R_{\bar{s}'} + R_{\bar{s}''} + \ldots \equiv R_{\overline{ss's''\ldots}} \text{ (mod. } p, K).$$

If X_s dehote any function of x which contains s and no factor of K not found in s, the analogue of Fermat's theorem is

$$X_s^{\tau_s(K)} \equiv R_s \text{ (mod } p, K);$$

and if ΠX_s denote the product of all the functions X_s of a less degree than K, the analogue of Wilson's theorem is

$$\Pi X_s \equiv R_s \text{ (mod. } p, K),$$

except s contain all but one of the factors of K, in which case

$$\Pi X_s \equiv -R_s \text{ (mod. } p, K).$$

Mr. Peirce called attention to the similarity existing between some of the above results and certain logical formulae.

On Two Kinds of k-th Totients, by W. E. Story.

If any number N is resolved into its prime factors, say $N = a^\alpha b^\beta c^\gamma \ldots$ the number

$$\tau^k(N) = a^{k(\alpha-1)} b^{k(\beta-1)} c^{k(\gamma-1)} \ldots (a^k - 1)(b^k - 1)(c^k - 1) \ldots$$

is the number of sets of k numbers each, neither greater than N, which do not all contain as a divisor any factor of N. This formula includes all the different permutations which can be obtained from any such set of k numbers. The number of such sets, excluding permutations, i. e. counting only one permutation to each set, is

$$\phi^k(N) = \frac{1}{k!}\left\{\tau^k(N) + t_1^k \cdot \tau^{k-1}(N) + t_2^k \cdot \tau^{k-2}(N) + \ldots + t_{k-1}^k \tau(N)\right\},$$

where $1, t_1^k, t_2^k, \ldots t_{k-1}^k$ are the coefficients of the successive descending powers of x in the expression $(x+1)(x+2)(x+3) \ldots (x+k-1)$.

Let now $a, b, c, \ldots$, instead of being the different prime factors of N, be the different *least* divisors of N, which have a given characteristic of any nature whatever. By a *least* divisor is meant one which is not a multiple of any other divisor of the given type. Let then the product of the binomial factors in the expression $\tau^k(N)$ above given be developed and every k-th power of a product of least divisors $a, b, c, \ldots$ be replaced by the k-th power of the least common multiple of such divisors occurring in that product. The value of $\tau^k(N)$ after these changes have been made and the value of $\phi^k(N)$ after the substitution of these forms of $\tau^k(N)$ will be the number of sets of k numbers each, none greater than N, which do not all contain any divisor of N having the given characteristic, respectively inclusive and exclusive of permutations. It is noticeable that if any divisor having the given characteristic, but not a least divisor of that type, were introduced into the formula the result would not be affected, provided account is taken of *all the least divisors.*

A. S. Hathaway also read a Paper on Modular Functions.

OFFICIAL ANNOUNCEMENTS.

CHARGES FOR TUITION.

By authority of the Trustees, February, 1881.

The charge for tuition is eighty dollars per year payable in two sums, forty dollars on the first of October, for the first half year, and forty dollars on the first of February, for the second half year. The Treasurer's office is not authorized to make a deduction for a period less than half a year, or to make a deduction because the student gives only a part of his time to study, or because he belongs to but one class.

Charges for materials, instruments, breakage, etc., are made in the laboratories, but there are no other extras.

Upon entering the University and before attending any class every student (*including the Fellows and the holders of Scholarships*) is required to deposit with the Treasurer the sum of ten dollars. This sum will be repaid to him when he withdraws from the University, if there are no charges against him in the Treasurer's office, the Library, the Laboratories, or elsewhere. A key to a coat closet will be furnished if asked for.

Holders of Fellowships and Scholarships are not charged the general tuition fee for any period after the date of their appointment. Holders of Scholarships are charged the fees for material, etc., made use of in the Laboratories.

Chemical Laboratory.

Workers in the Chemical Laboratory will be charged twenty dollars for the year, or ten dollars for the half year (in addition to the general tuition fee, which is eighty dollars,) for gas, chemicals, etc. From this charge Fellows only are exempt.

A charge will also be made, at the end of each year, against all (including Fellows) who work in the Laboratory for apparatus taken from the Laboratory stock and not returned in good condition.

Those who merely attend the annual course of Chemical lectures and have no other connection with the University, will pay for this privilege the sum of twenty dollars.

Biological Laboratory.

The fees for work in the Biological Laboratory are—

1. To undergraduate students, whether matriculates or not, taking the regular courses of instruction in Biology, there will be charged (in addition to the general tuition fee, which is eighty dollars.) twenty dollars, for material and the use of apparatus.
2. To medical men, graduate students and others taking only the annual course of instruction in Animal Physiology, with the corresponding laboratory practice, fifty dollars, which includes payment for material and the use of apparatus.
3. For a course of practical instruction in Histology, (including material and the use of apparatus), twenty-five dollars.
4. Students engaged in investigation or special individual work will be charged twenty dollars for the use of instruments, &c., and be required to pay for any material used except the usual histological and chemical reagents.
5. Those who merely attend the annual course of Biological lectures and have no other connection with the University will pay for this privilege the sum of twenty dollars.

NOTE IN RESPECT TO THE STUDY OF FRENCH AND GERMAN.

After a general consultation upon the subject, the following Note is published by authority of the Academic Council.

I. It is not required of every student to follow the French and German courses here prescribed; but no one will be allowed to graduate until he has given evidence that he has a knowledge of those languages, corresponding to that which may be acquired in the minor course here given.

II. The rudiments of French and German are not taught in this University. They may be learned by the student before or after his admission to the University; but they must be learned before he can enter here the classes in Modern Languages.

III. For admission to the minor course in German a candidate must show a knowledge of the inflections and of twenty-five pages of some German Reader.

For admission to the minor course in French the candidate must show as much knowledge as may be acquired by a study of Keetels' Analytic French Reader, Part I, and twenty-five pages of Part II; and of Ploetz' Grammaire nouvelle, (*Lexicographie.*)

IV. One year's successful study of either language counts as a minor course. The student who has completed a minor course, should be able to read, at sight, ordinary modern prose.

V. The major course, which occupies a second year, leads the student to a more critical study of the language, its history, structure and literature. The lessons are conducted in French or German, and the writing of essays is required.

VI. Students who have such an amount of knowledge as may be gained in the major courses, can pursue, if they choose, advanced courses of instruction as they are from time to time offered.

VII. If French and German are offered for matriculation, instead of Greek, the minor course in one and the rudiments of the other are required.

EXAMINATIONS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

The following statement in respect to the terms upon which the degree of Doctor of Philosophy is bestowed has been authorized by the Academic Council.

1. The candidate must have taken his first degree in a college of good standing.
2. An interval of three years or more must elapse between his baccalaureate examination and his graduation as Doctor of Philosophy.
3. He must be accepted as a candidate by the Academic Council of this University one year before his final examination.
4. He must file with the President, prior to his being accepted as a candidate, a statement of the principal and subordinate subjects on which he desires to be examined; and, when it is determined, a statement of the subject of his graduating thesis.
5. His thesis must be submitted to the Academic Council at least three months prior to the time when he proposes to pass his final examinations. This thesis will be carefully scrutinized, and, if found satisfactory, arrangements will be made for further oral or written examinations, one or more of which must be in the presence of the Academic Council.
6. In exceptional cases, by special permission of the Academic Council, non-resident students may be examined for this degree. Such scholars must be accepted at least two years before their final examination, and must prosecute their studies under such arrangements and conditions as shall meet with the approbation of the President and Professors of this University. In other particulars, the regulations above given will apply to these cases.

SPECIAL NOTICES AND CURRENT INTELLIGENCE.

VISIT OF PRESIDENT HAYES.

The President of the United States, **Rutherford B. Hayes**, visited Baltimore, Saturday, February 12, 1881.

By invitation of the Hopkins Trustees, he came to the University, at 3 P. M., and the officers and students were personally presented to him in Hopkins Hall. By a vote of the Trustees the honorary degree of Doctor of Laws was conferred upon him, and he acknowledged the compliment in a brief address.

COMMEMORATION DAY.

The twenty-second of February, 1881, was observed, according to usage, as the Commemoration Day of the Johns Hopkins University. At eleven o'clock in the morning, Hopkins Hall was filled with an assembly which included the Trustees, the Academic Staff, the Graduates, the Students, and a number of invited guests, among whom was the Mayor of the City. After an address by President Gilman, which occupied nearly an hour, and reviewed the present condition of the various departments and agencies of the University, the academic degrees were conferred as follows:

Bachelors of Arts.

Edwin G. Richardson, of Baltimore, who received his previous training at the Pembroke School, Baltimore, and pursued while at this University, studies in Greek and Latin as major subjects, and in History, German and French as minor subjects.

Lee Sale, of Louisville, Kentucky, a former student of the Louisville High School, who has finished major courses in Latin and Greek, and minor courses in History, German and Physics.

Doctor of Philosophy.

Christian Sihler, of Cleveland, Ohio, who received his academic education at a German gymnasium, the Concordia College, in Indiana. He then entered the Medical Department of the University of Michigan, where he received the degree of Doctor of Medicine in 1871. He has been connected with the Johns Hopkins University for three years, as Student, Fellow, and Assistant in the Biological Laboratory. He was examined in Animal Physiology as his main subject, and in Animal Morphology and Chemistry, as subordinate subjects. His thesis, on "The Formation of Bone and Tooth," was submitted to Dr. George A. Otis, of the U. S. Surgeon-General's Office, Washington.

An address had been expected from Dr. A. Graham Bell, of Washington, but, on the day previous, a telegram was received from him, saying that ill health prevented him from complying with the invitation.

In the evening, from 8 to 11 o'clock, the library and halls of the University were thrown open to a company of gentlemen and ladies, several hundred in number.

MEETING OF AMERICAN LIBRARY ASSOCIATION.

The **American Library Association** held the final session of its annual meeting in Hopkins Hall, Friday, February 11; the previous sessions having been held in Washington. Among those present were Justin Winsor, of Harvard University, President of the Association; Melvil Dewey, Secretary of the Association; H. F. Bassett, Waterbury, Conn.; E. C. Bigmore, London; J. S. Billings, Surgeon-General's Office; Alice J. Bragdon, Public Library, South Boston; Mellen Chamberlain, Boston Public Library; E. Cleaves, Boston; R. Colton, American Antiquarian Society Library; C. A. Cutter, Boston Athenaeum; C. C. Darwin, Congressional Library; Sarah F. Earl, Worcester Public Library; John Edmands, Philadelphia Mercantile Library; W. E. Foster, Providence Public Library; Sarah C. Godbold, Public Library, East Boston; S. S. Green, Worcester Public Library; W. M. Griswold, Bangor, Me.; G. W. Haines, Cornell University; H. A. Homes, New York State Library; J. K. Hoyt, Newark, N. J.; D. Hutchinson, Washington; F. Jackson, Newton, Mass.; J. N. Larned, Young Men's Library, Buffalo; F. Leypoldt, New York; C. N. Merrill, Cincinnati Public Library; E. J. Nolan, Philadelphia Academy of Sciences; S. B. Noyes, Brooklyn Library; W. T. Peoples, New York Mercantile Library; W. F. Poole, Chicago Public Library; R. B. Poole, New York Young Men's Christian Association; W. J. Rhees, Smithsonian Institution; O. H. Robinson, University of Rochester; Mrs. M. A. Sanders, Pawtucket Free Library; A. W. Tyler, Indianapolis Public Library; F. Vinton, College of New Jersey.

Representatives of the principal Baltimore literary institutions were also present.

J. W. M. Lee, of the Mercantile Library; P. R. Uhler, of the Peabody Institute; and W. Hand Browne, of the University Library, acted as a committee of reception.

President Gilman welcomed the Association to Baltimore, and expressed his obligations and those of his colleagues to the librarians who have generously lent for use in Baltimore such books as have been called for in the prosecution of University work.

Papers were read by O. H. Robinson, of the University of Rochester, on "The Relation of Libraries to College Work," and by S. S. Green, of the Worcester Public Library, on "Library Aids."

After a lunch, to which the Association was invited by the Trustees of the University, the members of the Association visited the Peabody Institute, the Mercantile Library and the rooms of the Maryland Historical Society.

DUPLICATES IN LIBRARY.

The following volumes will be exchanged, or sold at annexed prices. Where no binding is specified, the book is unbound. Address Dr. W. Hand Browne, Librarian.

Arbeiten aus d. Physiol. Anstalt. Leipzig. Bd. 10, 8vo. hf. mor., Leipzig: 1876,	75
Arbeiten a. d. Zoolog.-zoot. inst. z. Würzburg IV, 1, 8vo. Hamburg: 1877	75
Archiv fur Anthropologie VIII, 3, 4, 4to., Braunschweig: 1876	2 50
Archiv. f. mikroskop. anatomik. XIII, 8vo., Bonn: 1876–7	5 00
Archivio glottologico Italiano. V, 1, 8vo., Rome: 1878; VII, 1, 8vo., Rome: 1880, Each	50
Aristophanes. Frösche. Ed. Kock, 8vo., Berlin: 1868	50
Bain. Logic. 2 v., cr. 8vo., cloth (worn), London: 1870	1 75
Baudissin. Studien z. Semit. religionsgeschichte hft. 2, 8vo., Leipzig: 1878	75
Boehmer. Romanische Studien. XV, 8vo., Bonn: 1880	4 00
Doederlein. Homerisches Glossar. 3 v, 8vo., hf. mor. Erlangen: 1850	2 50
Düntzer. Homerische Abhandlungen, 8vo hf. mor., Leipzig: 1872	1 50
Hegel. Encyclopädie, 2 v., 8vo., hf cf., Berlin: 1843	2 00
Hegel. Philosophie der Geschichte, 8vo., hf. cf., Berlin: 1840	1 00
Hegel. Rechtsphilosophie, 8vo., hf. cf., Berlin: 1840	1 00
Herbart. Einleitung in die Philosophie, hf. cf., Leipzig: 1850	1 50
Hobbes. English works, Vol. I, 8vo., cloth, London: 1839	75
Hofmann u. Schwalbe. Jahresb. u. d. fort. d. Anat. u. Physiol. V. 2, Leipzig: 1878	25
Holland. Roumans dou Chevalier au Lyon, 2d ed., 8vo., hf. mor., Hannover: 1880,	1 50
Hume. Essays. 2 v, 8vo., old cf., London: 1788	2 00
Jacob. Bedeutung der Führer Dantes, pph., Leipzig: 1874	25
Journal of Philology, VII, 8vo., London: 1876	1 00
Journal de Mathematiques, (Liouville), III, Série I, 4to., Paris: 1875	3 50
Literaturblatt f. germ. u. roman. Philologie Nos. 1–7, 4to., Heilbronn: 1880,	75
London Math. Soc. Proceedings. Nos. 159–162, 8vo., London: 1880	50
Marey. Physiologie Expérimentale, IV, 8vo., Paris: 1880	2 00
Nitzsch. Epische Poésie der Griechen, 8vo., hf. mor., Leipzig: 1862	2 50
Pflüger. Archiv. f. d. gesammt. Physiologie, XIV, 8vo., Bonn: 1877	2 00
Poggendorff's Annalen. Ergänzungsb., VIII, 8vo., Leipzig: 1877	25
Prantl. Geschichte der Logik, 4 v., 8vo., hf. mor., Leipzig: 1855	5 00
Preger. Dante's Matelda. München: 1873	25
Ravaisson. La Philosophie en France au XIX Siècle, 8vo., hf. mor., Paris: 1868	1 50
Rehdantz. Indices z. Demosthenes Philippische Reden, 8vo., Leipzig: 1874	25
Scartazzini Dante, sein Zeit, sein Leben, &c., 8vo., Biel: 1869	1 00
Schmidt. Das Perikleische Zeisalter., Bd. 1, 8vo., hf. mor., Jena: 1877	75
Schmidt-Mülheim. Physiol. d. Haussäugethiere, 8vo., Leipzig: 1879	1 50
Steinthal. Geschichte der Sprachwissenschaft., 8vo., hf. mor., Berlin: 1863	2 00
Stewart, Dugald. Works, 11 v., 8vo., cloth, Edinburgh: 1854	12 00
Trendelenburg. Logische Untersuchungen, 2 v., 8vo., Leipzig: 1870	2 00
Wöhler. Mineralanalyse, 8vo., hf. mor., Göttingen: 1861	75
Zeitsch. f. deutsche Philologie VII, 8vo., Halle: 1876	1 50
Zeitsch. f. romanische Philologie I, 8vo., Halle: 1877	1 50

SEMI-ANNUAL EXAMINATIONS.

First Half-Year, 1880–81.

Semi-Annual Examinations were held according to the following ule:

Saturday, January 15.

Prose Composition, *Classes A and B.* (7)
iology. (2)

Wednesday, January 19.

h: Major. (8)
n Osteology. (3)

Thursday, January 20.

n Osteology. (8)

Saturday, January 22.

an: Minor, Schiller, *Prose.* (18)
an: Schiller, *Wallenstein.* (10)

Monday, January 24.

ce. (11)
al Biology. (3)

Tuesday, January 25.

al Physiology. (5)

Wednesday, January 26.

an Grammar and Prose Composition. (18)
an: Schiller, *Prose.* (7)

Friday, January 28.

rn History. (18)
al Biology. (8)

Saturday, January 29.

cal Economy. (11)
culation in Algebra. (14)
culation in Geometry. (20)

Monday, January 31.

al Physiology. (5)
Prose Composition. (10)

Wednesday, February 2.

: Livy. (11)
: Sophocles, *Electra*, *Antigone.* (5)
: Herodotus, I, II (*private reading*). (1)
: Horace, *Od.* III, IV, *Epod.*, etc. (*private reading*). (1)

Thursday, February 3.

: Livy. (11)
: Sophocles, *Electra*, *Antigone.* (5)

Saturday, February 5.

h: Minor. (8)
n: Dante. (4)
al Physics. (18)

Monday, February 7.

al Physics. (13)
culation in Latin. (8)

Wednesday, February 9.

an: Goethe, *Egmont* (11)
an Prose Composition and Bauer's Grammatik. (8)

Thursday, February 10.

an: Goethe, *Egmont.* (11)

Saturday, February 12.

: Tacitus. (8)
ential Calculus. (4)
culation in Trigonometry. (18)
culation in Analytical Geometry. (12)

Thursday, February 15.

h: Minor. (8)

Wednesday, February 16.

: Livy (*private readings*). (6)
: Tacitus (*private readings*). (8)

Saturday, February 19.

: Herodotus. (4)
y of Functions. (8)
an Grammar and Prose Composition. (suppl). (8)
: Homer. *Odyssey*, I–VI (*private readings*). (1)
: Euripides. *Alcestis* (*private readings*). (2)
culation in Greek. (2)

Wednesday, February 23.

: Herodotus. (4)
: Cæsar, *Bell. Civ.* (*private readings*). (1)

Thursday, February 24.

cal Trigonometry. (1)

Saturday, February 26.

h: Major. (8)

Thursday, March 3.

: Homer, *Odyssey*, VII–XII (*private reading*). (1)

ADDITIONS TO ROLL OF STUDENTS.

(The full list of Officers and Students for the current year, will be found in University Circulars, No. 8, pp. 91–93.)

Applegarth, Albert C. Baltimore City College. *Candidate.*	Baltimore.	348 *Lexington St.*
Cooke, Charles A. Baltimore City College. *Chemistry.*	Baltimore.	96 *Harlem Ave.*
Cooke, Frederick H. A. B., Williams College, 1880. *Greek.*	Rock Bottom, Mass.	168 *Druid Hill Ave.*
Davis, Ellery W. S. B., University of Wisconsin, 1879. *Mathematics.*	Oconomowoc, Wis.	156 *W. Biddle St.*
Durfee, William P. A. B., University of Michigan, 1876. *Mathematics.*	Berkeley, Cal.	*Belvidere House.*
Miller, John H. A. B., Erskine College, (S. C.), 1880. *Mathematics.*	Camden, Ala.	268 *N. Howard St.*
Noyes, William A. A. B., Iowa College, 1879. *Chemistry.*	Grinnell, Iowa.	19 *McCulloh St.*
Treadwell, William H. Ph. D., University of Heidelberg, 1880. *Philosophy.*	Portsmouth, N. H.	43 *Cathedral St.*
Whiting, Guy F. M. D., University of Maryland, 1878. *Biology.*	Baltimore.	148 *W. Lanvale St.*

Total number of Enrolled Students, 1880–81, 177, of whom 97 are Graduates.

FELLOWSHIPS.

Twenty Fellowships, each yielding five hundred dollars are annually awarded by the Johns Hopkins University to college graduates who desire to pursue special advanced courses of study. A circular explaining the system will be sent on application. *Applications for the next year should be made prior to May* 13, 1881.

BRIEF ANNOUNCEMENTS.

Dr. Austin Scott, Associate in History, in place of the course of public lectures heretofore announced to be given by him, will begin a class course of instruction in American Constitutional History, Wednesday, April 6, at 12 M., and continue the same on Wednesdays, at 4 P. M., and Saturdays, at 12 M., until May 25, 1881.

The lectures of **Professor A. Graham Bell** on "Speech" may be expected in October next. Ill health and a pressure of engagements have prevented him from delivering them during the current year. He has however consented to give one lecture upon the Photophone, in Hopkins Hall, April 22, 1881.

Professor John McCrady, of the University of the South, Sewanee, Tenn., formerly Professor of Zoölogy in Harvard University, will give a course of six public lectures on the Theory of Development and its Philosophical Significance, in Hopkins Hall, beginning Thursday, March 31, and continuing on Friday, April 1, Monday, April 4, Tuesday, April 5, Friday, April 8 and Monday, April 11.

M. Rabillon, Lecturer on French Literature, began a course of ten lectures (in French), on French Poetry, etc., Saturday, March 5, and will continue them on successive Saturdays until May 7.

Samuel F. Clarke, Ph. D., Assistant in the Biological Laboratory, has been invited to lecture on Natural History at Smith College, Northampton, Mass. He will give instruction in Elementary Zoölogy, at the Chesapeake Zoölogical Laboratory, during its next session, as heretofore announced.

Kakichi Mitsukuri, Ph. B., Fellow in Biology, has returned to the University of Tokio, Japan, and has consequently resigned the Fellowship held by him here.

Arthur Wilson Wheeler, A. B., of Rockland, Mass., a graduate of Amherst College in 1879, and a Fellow in Physics of this University, died in Baltimore, January 6, 1881, aged 21 years. A brief memorial notice of him has been printed and distributed.

Harry Swann, a native of England, who has been one of the janitors of this institution since 1876, died March 15, at the age of 27 years. He was an obliging, industrious and faithful man who was struggling against adversities, in a brave and helpful spirit, respected by all who knew him.

The Medical and Chirurgical Faculty of Maryland will hold its next session in Hopkins Hall, beginning April 12, 1881.

DEATH OF

GALLOWAY CHESTON,

First President of the Board of Trustees of the Johns Hopkins University,

who was born in Baltimore, May 31, 1806, and died in Baltimore, March 9, 1881,

In the seventy-fifth year of his age.

BIOGRAPHICAL NOTE.

Galloway Cheston, the son of James Cheston, a successful merchant, passed his life in Baltimore, the place of his birth. After receiving a good education in St. Mary's College, before its well known academic department was given up, he engaged with success in mercantile pursuits. He was called to many positions of financial trust, and was selected to be a director in various philanthropic and educational institutions. In all these stations and in the various relations of private life he commanded the respect of those who knew him as an exemplary and upright man, attentive to every duty and governed by an unwavering Christian faith. He seldom failed to attend the meetings of the Board and was always the advocate of a liberal and enlightened policy.

The following statements regarding his life were published in the Baltimore American, March 10, 1881:

Galloway Cheston, after receiving an academic education, went into business with his father under the firm name of Cheston & Son, millers and flour merchants. The firm afterwards did a large business in the importation of coffee from Brazil. Mr. Cheston was in business in Baltimore for nearly half a century, and acquired a most excellent reputation for probity and intelligence, as well as for his success as a merchant. He was for a long time president of the Copper Smelting Company. One of the most responsible offices that he ever filled was that of chairman of the Finance Committee of the Baltimore and Ohio Railroad Company, after being a prominent director in the company. His rare business tact, shrewdness, and ability as a financier were so generally recognized, that at the death of the late Johns Hopkins, who had for many years been at the head of the finance committee of the road, he was unanimously chosen to succeed him. The excellent manner in which he discharged the duties of that office attested the wisdom of his selection for that important trust. He was for many years a director in the Farmers and Planters' Bank, of which his father, James Cheston, was the first president, . . . and also in the Savings Bank of Baltimore and in the Peabody Fire Insurance Company. His was a very active business life, and the large number of positions which he held shows the confidence reposed in him by those with whom he came in contact in his long mercantile career. . . . . He was president of the Board of Trustees of the Johns Hopkins University, a trustee of the Johns Hopkins Hospital, a trustee of the Peabody Institute, a director in the Manual Labor School, a director of the Maryland Bible Society, a director of the Baltimore Orphan Asylum and of similar institutions. He married a daughter of Mr. James Carey, a well-known Baltimore merchant. His wife preceded him to the grave several years ago. She died childless. Mr. Cheston retired from business some years since. He was an attendant at the meetings of the Orthodox Society of Friends, on Monument Street.

Minute adopted at a meeting of the Trustees and Academic Staff, March 15, 1881.

At a meeting of the Trustees and Academic Staff, the chair having been taken by Hon. George W. Dobbin, the following minute was presented by Hon. C. J. M. Gwinn, and after remarks by the mover, and by President Gilman, Mr. Francis T. King, and Judge Dobbin, was unanimously adopted. The action of the meeting was communicated to the family of Mr. Cheston, and will be entered upon the records of the Trustees.

"The Board of Trustees of the Johns Hopkins University, its President, Professors and Associates, having assembled to make some fitting record of the loss, by death, of Galloway Cheston, the President of its Board of Trustees, hereby record their estimate of his character and services.

"Mr. Cheston, who had been well known from his boyhood to the founder of this University, was named by him, when it was first organized, as the President of its Board of Trustees.

"He fully justified the choice thus made. Kindly, but firm in temper, broad, thoughtful and charitable in opinion, prudent and laborious in action, and pure in heart, his advice and effort have greatly aided in laying deep and strong the foundations of this University. If it should grow to greatness, as we trust it will, his name will be imperishably connected with its history."

JOHNS HOPKINS
UNIVERSITY CIRCULARS.

Published with the approbation of the Board of Trustees.

No. 11.] BALTIMORE, JULY, 1881. [PRICE 5 CENTS.

CALENDAR, ACADEMIC YEAR, 1881–82.

September 20.	**Next Term Begins.**
September 21—24.	**Examinations for Matriculation.**
September 27.	**Instructions Resumed: Assembly of all the Officers and Students in Hopkins Hall.**
December 23—January 3.	**Recess.**
February 22.	**Commemoration Day.**
April 7—10.	**Spring Recess.**
June 9.	**Next Term Closes.**

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MEETINGS OF SOCIETIES.

Scientific. First Wednesday of each month, at 8 P. M. Next meeting, October 5.

L. B. Fletcher, Secretary.

Philological. First Friday of each month, at 12 M. Next meeting, October 7.

M. Warren, Secretary.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, October 11.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, October 21.

H. B. Adams, Secretary.

Mathematical. Third Wednesday of each month, at 8 P. M. Next meeting, October 19.

O. H. Mitchell, Secretary.

Naturalists' Field Club. Excursions each Saturday during the Spring and Autumn. Regular meetings for the reading and discussion of papers once a month.

H. F. Reid, Secretary.

322 D. 801

ACADEMIC STAFF, 1881-82.

President and Professors.

Daniel C. Gilman. 81 Saratoga St. *President.*
A. B., Yale College, 1852, and A. M., 1855; LL. D., Harvard University and St. John's College, 1876; Professor in Yale College, 1863-72; President of the University of California, 1872-75.

Basil L. Gildersleeve. 258 St. Paul St. *Greek.*
A. B., Princeton College, 1849, and A. M., 1852; Ph. D., University of Göttingen, 1853; LL. D., College of William and Mary, 1869; Professor of Greek in the University of Virginia, 1856-76; Professor of Latin in the University of Virginia, 1861-66.

H. Newell Martin. 221 St. Paul St. *Biology.*
M. B., University of London, 1871, and Dr. Sc., 1872; A. B., University of Cambridge, 1874, and A. M., 1877; Fellow, and late Lecturer on Natural History in Christ College, Cambridge; Fellow of University College, London; M. D., (Hon.) University of Georgia, 1881.

Charles D. Morris. (Collegiate) 158 N. Howard St. *Latin and Greek.*
A. B., Lincoln College, Oxford, 1849, A. M., and Fellow of Oriel College, Oxford, 1852; Professor in the University of New York, 1875-76.

Ira Remsen. 213 St. Paul St. *Chemistry.*
College of the City of New York; M. D., College of Physicians and Surgeons, N. Y., 1867; Ph. D., University of Göttingen, 1870; Professor of Chemistry in Williams College, 1872-76, and previously Assistant in Chemistry in the University of Tübingen.

Henry A. Rowland. 14 Cathedral St. *Physics.*
C. E., Rensselaer Polytechnic Institute, 1870; Assistant Professor in the same, 1872-75; Ph. D., Johns Hopkins University, 1880.

J. J. Sylvester. Mt. Vernon Hotel. *Mathematics.*
A. M., University of Cambridge; F. R. S., London and Edinburgh; Corresponding Member, Institute of France; Member, Academy of Sciences in Berlin, Göttingen, Naples, Milan, St. Petersburg, etc.; LL. D., University of Dublin, University of Edinburgh; D. C. L., University of Oxford; Honorary Fellow of St. John's College, Cambridge; late Professor of Mathematics in the Royal Military Academy, Woolwich; Copley Medalist, Royal Society, London, 1880.

Lecturers.

A. Graham Bell, Ph. D.	Washington.	*Phonology.*
W. W. Goodwin, Ph. D.	Cambridge.	*Plato's Republic.*
G. Stanley Hall, Ph. D.	Cambridge.	*Psychology.*
John J. Knox, A. M.	Washington.	*Banking.*
S. P. Langley, Ph. D.	Alleghbeny.	*Physics.*
Sidney Lanier.	Baltimore.	*English Literature.*
George S. Morris, A. M.	Ann Arbor.	*History of Philosophy.*
Simon Newcomb, LL. D.	Washington.	*Political Economy.*
Charles S. Peirce, A. M.	Baltimore.	*Logic.*
Leonce Rabillon, Bach. ès Lett.	Baltimore.	*French Literature.*
Richard M. Venable.	Baltimore.	*Constitutional Law.*

Associates.

Herbert B. Adams. 123 W. Madison St. *History.*
A. B., Amherst College, 1872; Ph. D., University of Heidelberg, 1876; Lecturer on History at Smith College.

Maurice Bloomfield. *Sanskrit.*
A. M., Furman University, 1877; Ph. D., Johns Hopkins University, 1879.

Herman C. G. Brandt. 890 Druid Hill Ave. *German.*
A. B., Hamilton College, 1872, and A. M., 1875; Assistant Professor of Modern Languages in Hamilton College, 1874-76.

William K. Brooks. 181 N. Calvert St. *Biology.*
A. B., Williams College, 1870; Ph. D., Harvard University, 1875; Director of the Chesapeake Zoölogical Laboratory.

William Hand Browne. 2 Huntingdon Ave. *Librarian.*
M. D., University of Maryland, 1850.

Thomas Craig. Washington, D. C. *Applied Mathematics.*
C. E., Lafayette College, 1875; Ph. D., Johns Hopkins University, 1878; of the U. S. Coast and Geodetic Survey.

A. Marshall Elliott. 142 N. Charles St. *Romance Languages.*
A. B., Haverford College, 1866, and A. M., 1878; A. B., Harvard University, 1868.

Charles S. Hastings. 8 Denmead St. *Physics.*
Ph. B., Yale College, 1870, and Ph. D., 1873; Holder of the "Tyndall Scholarship" in Paris, 1875.

Harmon N. Morse. 12 Denmead St. *Chemistry.*
A. B., Amherst College, 1873; Ph. D., University of Göttingen, 1875; Instructor in Chemistry at Amherst College, 1875-76.

Austin Scott. Washington, D. C. *History.*
A. B., Yale College, 1869; A. M., University of Michigan, 1870; Ph. D., University of Leipsic, 1873; late Instructor in History at the University of Michigan.

William T. Sedgwick. 89 Mt. Vernon Place. *Biology.*
Ph. B., Yale College, 1877; Ph. D., Johns Hopkins University, 1881.

Henry Sewall. 48 McCulloh St. *Biology.*
S. B., Wesleyan University, 1876; Ph. D., Johns Hopkins University, 1879.

William E. Story. 41 Franklin St. *Mathematics.*
A. B., Harvard University, 1871; Ph. D., University of Leipsic, 1875; Tutor of Mathematics in Harvard University, 1875-76.

Philip R. Uhler. 218 W. Hoffman St. *Natural History.*
Librarian of the Peabody Institute, and President of the Maryland Academy of Sciences.

Minton Warren. 89 Mt. Vernon Place. *Latin.*
A. B., Tufts College, 1870; Ph. D., University of Strassburg, 1879.

Instructors and Assistants.

R. Dorsey Coale. 215 Madison Ave. *Chemistry.*
Ph. D., Johns Hopkins University, 1881.

Lawrence B. Fletcher. 263 N. Howard St. *Physics.*
A. B., Columbia College, 1877, and A. M., 1880; Fellow of Columbia College, 1877-80; Ph. D., Johns Hopkins University, 1881.

Fabian Franklin. 228 W. Lanvale St. *Mathematics.*
Ph. B., Columbian University, 1869; Ph. D., Johns Hopkins University, 1880.

Philippe B. Marcou. 33 Hamilton St. *French.*
A. B., Harvard University, 1876, and A. M., 1879.

Hugh Newell, Maryland Institute. *Drawing.*
Instructor in Drawing in the Maryland Institute.

George F. Nicolassen. 600 W. Lombard St. *Greek and Latin.*
A. B., University of Virginia, 1879, and A. M., 1880.

Edmund B. Wilson. 172 W. Biddle St. *Biology.*
Ph. B., Yale College, 1878; Ph. D., Johns Hopkins University, 1881.

Charles L. Woodworth, Jr. 205 N. Howard St. *Elocution.*
Amherst College.

Fellows by Courtesy.

Edward M. Hartwell. *Biology.*
A. B., Amherst College, 1873, and A. M., 1876; Ph. D., Johns Hopkins University, 1881.

Mitsuru Kuhara. *Chemistry.*
S. B., University of Tokio, Japan, 1877.

Robert W. Prentiss. *Mathematics.*
S. B., Rutgers College, 1878.

Henry A. Short. *Greek.*
A. B., Columbia College, 1880; Fellow of Columbia College.

George M. Sternberg. *Biology.*
M. D., College of Physicians and Surgeons, N. Y.; Surgeon, U. S. A.

Charles A. Van Velzer. *Mathematics.*
S. B., Cornell University, 1876.

Fellows.

William J. Alexander. *Greek.*
A. B., University of London, 1876.

James W. Bright. *Teutonic Languages.*
A. B., Lafayette College, 1877, and A. M., 1880.

Edward S. Burgess. *Greek.*
A. B., Hamilton College, 1879.

William J. Comstock. *Chemistry*
Ph. B., Yale College, 1879.

William C. Day. *Chemistry.*
A. B., Johns Hopkins University, 1880.

Henry H. Donaldson. *Biology.*
A. B., Yale College, 1879.

William P. Durfee. *Mathematics.*
A. B., University of Michigan, 1876.

George S. Ely. *Mathematics.*
A. B., Amherst College, 1878.

Spencer H. Freeman. *Physics.*
A. B., University of Rochester, 1875, and A. M., 1878.

J. Franklin Jameson. *History.*
A. B., Amherst College, 1879.

C. Herschel Koyl. *Physics.*
A. B., Victoria University, Ontario, 1877.

Oscar H. Mitchell. *Mathematics.*
A. B., Marietta College, 1875, and A. M., 1878.

Bernard F. O'Connor. *Romance Languages.*
Bach. ès Lettres, Université de France, 1874.

Henry L. Osborn. *Biology.*
A. B., Wesleyan University, 1878.

Chase Palmer. *Chemistry.*
A. B., Johns Hopkins University, 1879.

Herbert M. Perry. *Mathematics.*
A. B., Harvard University, 1880.

Edward H. Spieker. *Greek.*
A. B., Johns Hopkins University, 1879.

Henry N. Stokes. *Biology.*
S. B., Haverford College, 1878.

Morrison I. Swift. *Philosophy.*
A. B., Williams College, 1879.

Benjamin W. Wells. *English.*
A. B., Harvard University, 1877, and Ph. D., 1880.

NOUNCEMENT OF COURSES AND LECTURES FOR 1881-82.

e following announcements are made by the several instructors in respect to the Lectures and other Courses of Instruction
;iven during the next academic year.
ese statements should be read in connection with the Register for 1880–81, to which they are in part supplementary. In
:gister will be found a full statement of the work performed during the last academic year and of the methods of instruc-
re pursued. Copies may be obtained on application by postal card to the "Johns Hopkins University."
idents who propose to enter here in the Autumn are requested to address their letters of inquiry and application to "The
nt of the Johns Hopkins University" rather than to any person by name.

MATHEMATICS.

athematical Seminary.

instructors and more advanced students in Mathematics
et monthly, as heretofore, under the presidency of **Professor**
ster, as a *Mathematical Seminary*, for the presentation
cussion of papers or oral communications.

esults of special studies upon the following subjects, among others,
en examined and discussed at the meetings of the Seminary during
three academic years:

-79, Newton's rule for the limits of roots of algebraic equations; the rule of signs
metry; barycentric coördinates; double points of plane curves; the quasi-evo-
:ral harmonic transformation; special cases of Pascal's hexagram; transforma-
liptic coördinates.

-80, a generalized form of analytical triangle; on vector ratios considered as
:tric functions of angles; on the condition that a linear total differential equa-
ie first order in any number of variables may admit of a single primitive; a
ation, for *n*-fold space, of Euler's equation for polyhedra; a completion of For-
orem; on generalized forms of trigonometric ratios; on volumes and surfaces of
ional spheres; on triangles in- and ex-scribable to a general cubic curve; on bi-
ongruences; rotation in four-dimensional space; a general method of congru-
l its application to the theory of cyclotomic functions; completion of Wilson's
and on the number of *n*th residues.

-81, on the resultant of two congruences; on the multisection of the roots of
ı the prerogative of a ternary denominational system of coinage; on a notation
ts; on two kinds of *k*-th totients; outline of Clebsch and Gordan's method of
ie groundforms of a binary quantic; a proof of Abel's theorem; proof that there
three linear associative algebras in which division is an unambiguous process; a
ı from the properties of a system of three circles; on v. Gall's table of ground-
the octavic; a new proof of Euler's development of the infinite product $(1-x)$
$l-x^3)\ldots$; on Newton's method of approximation; upon the similarity between
ces and equations and its significance; the cyclotomic functions, with respect to a
odulus p; on modular functions; on the properties of the roots of $x^2 = x$ mod. k;
n including Fermat's and Wilson's theorems; on binomial congruences, (mod.
on a rule of signs in determinants; a problem in maxima and minima; a geo-
cus; on certain compound determinants.

cts of most of these papers have been given in successive numbers of the Uni-
irculars.

Advanced Courses.

:heory of Numbers. *Twice weekly during the first half-*
Professor Sylvester.

)eterminants and Modern Algebra. *Twice weekly during*
:ond half-year. **Professor Sylvester.**

}uaternions. *Three times weekly through the year.* **Dr.**

ıdvanced Topics of Higher Plane Curves. *Three times*
y during the first half-year. **Dr. Story.**

ıdvanced Topics of Solid Geometry. *Three times weekly*
g the second half-year. **Dr. Story.**

:lliptic Functions and Introduction to General Theory of
ions. *Three times weekly during the first half-year.*
raig.

ıbelian Functions. *Three times weekly during the second*
rear. **Dr. Craig.**

}pherical Harmonics. *Twice weekly during the first half-*
Dr. Craig.

9. Partial Differential Equations. *Three times weekly during the second half-year.* **Dr. Craig.**

10. Calculus of Finite Differences. *Three times weekly during the second half-year.* **Dr. Franklin.**

11. Calculus of Variations. *Twice weekly during the first half-year.* **Dr. Craig.**

12. Mechanics of Rigid Bodies. *Three times weekly during the first half-year.* **Dr. Craig.**

13. Elasticity and Hydrodynamics. *Three times weekly during the second half-year.* **Dr. Craig.**

III. Major and Minor Courses.

14. Conic Sections. *Three times weekly during the first half-year.* **Dr. Story.**

15. Higher Plane Curves [Elementary Course]. *Three times weekly during the second half-year.* **Dr. Story.**

16. Spherical Trigonometry. *Twice weekly during the second half-year.* **Dr. Franklin.**

17. Solid Analytic Geometry [Elementary Course]. *Three times weekly during the first half-year.* **Dr. Franklin.**

18. Differential and Integral Calculus. *Three times weekly through the year.* **Dr. Franklin.**

19. Total Differential Equations. *Three times weekly during the first half-year.* **Dr. Franklin.**

IV. Logic.

The courses in Logic will be conducted by **Mr. C. S. Peirce**, and are announced on page 142.

PHYSICS.

I. Laboratory Work.

The Physical Laboratory, well equipped with instruments (especially with reference to researches in Heat, Electricity and Magnetism), is open to advanced students, under the direction of **Professor Rowland**, from 9 A. M. to 5 P. M.

The Laboratory is also open to the students pursuing the major course in this subject, and, for a weekly exercise, to the class in General Physics.

II. Lectures.

1. **Professor Rowland** will lecture on *Thermodynamics*, on the *Theory of Heat Conduction*, and possibly on *Sound.*

2. **Dr. Hastings** will conduct the major course which will include lectures weekly through the year, in addition to the work in the Laboratory.

3. Dr. Hastings will give the instruction in *General Physics* (including Mechanics, Light, Sound, Heat, Electricity and Magnetism).* There are daily exercises through the year, including two lectures, three recitations, and one practical lesson in the Laboratory, (to which a select number of students is admitted), weekly.

* To enter this class, a knowledge of Trigonometry is essential.

CHEMISTRY.

I. Laboratory Work.

The Chemical Laboratory, a new and well arranged building, thoroughly equipped, is open daily from 9 A. M. to 5 P. M. The work of the advanced students is under the direction of Professor Remsen, (who is in the Laboratory for consultation during the regular working hours), and he will also, with the coöperation of Dr. H. N. Morse and Dr. R. D. Coale, direct the general laboratory work.

II. Lectures.

1. Lectures in *General Chemistry* will be given, four times weekly during the first half-year, by Professor Remsen, and two examinations on these lectures will also be held each week by Dr. Coale. During the second half-year, the lectures and examinations in General Chemistry will be continued by Dr. Morse.

2. Lectures on the *Chemistry of Carbon Compounds* will be given by Professor Remsen, four times weekly during the second half-year.

3. Lectures on *Analytical Chemistry* will be given weekly by Dr. Morse, through the year.

4. There will be a course in *Mineralogy* conducted by Dr. Morse. It will consist of work in determinative mineralogy for eight to ten hours weekly through the year; two lectures weekly during the first half-year; and one weekly during the second half-year. This course is open to those only who have had at least a minor course in Chemistry.

5. Lectures on special topics in Chemistry, for advanced students, by Professor Remsen. The first of these courses will probably be on Berthelot's "*Essai de Mécanique Chimique.*"

BIOLOGY.

I. Laboratory Work.

1. The Biological Laboratory, which contains an unusually complete collection of physiological instruments, is constantly open under the direction of Professor Martin. Opportunities for physiological and morphological research are afforded to those who may be found qualified to undertake it, and instruction is given to advanced students, and also to those who desire a knowledge of Biology as introductory to the study of medicine, or as a branch of a liberal education.

2. The Chesapeake Zoölogical Laboratory is open for the present year, during the warmer months, at Beaufort, N. C., under the direction of Dr. W. K. Brooks. It is a station for the prosecution of original researches in respect to the marine life of the Atlantic sea-board, and advanced students only are received.

II. Lectures.

1. Professor Martin will give an advanced course of lectures on *Animal Physiology*, twice weekly during the academic year.

2. Dr. Brooks will lecture from the commencement of the session to the close of April on *Human and Comparative Osteology* and on the *Anatomy of the Mammalia.*

3. Dr. Sewall will meet for lectures or recitations a less advanced class in *Animal Physiology*, four times weekly through the year.

4. Dr. Sedgwick will meet for lectures or recitations a class in *General Biology*, four times weekly during the academic year.

5 Instruction in the elements of *Systematic and Structural Botany* will be given in connection with Field Excursions.

GREEK, SANSKRIT AND LATIN.

I. The Greek Seminarium, directed by Professor Gildersleeve.

Higher instruction in Greek is imparted chiefly through the agency of the seminarium, in which the students are brought into closer relations with the professor and encouraged to perform more independent work and engage in more extended experiments than would be possible on a system of mere recitation or the simple hearing of lectures. The plan of the seminarium, as developed especially in the last three years, is based on the continuous study of one great author or one great department of literature. Each regular member is required to take his turn as interpreter, critic, analyst, and special fields of research are assigned according to progress or bent. It may be added that while the seminarium demands a large portion of the student's time, the requirements are not so great as to preclude independent study in other directions, and care is taken so to direct his private reading that in the usual period of preparation for the higher degrees a comprehensive knowledge of Greek Literature and Greek life may be gained.

The seminarium consists of the Director, Fellows, and Scholars, together with such advanced students as may be found qualified to profit by the instruction and exercises.

During the next academic year, *the study of* Plato *and of the literary form of Greek philosophy* will constitute the chief occupation of the members.

In connection with the seminarium, the Director will interpret the *Symposion* of Plato once a week with conferences on topics suggested by the text.

Professor W. W. Goodwin, of Harvard University, will give three lectures on the Republic of Plato, early in February.

The philosophy of Plato will also be taken up in a series of lectures by Professor G. S. Morris in his course on Greek Philosophy.

It is important that all should be provided in advance with Ritter and Preller's *Historia philosophiae ex fontium locis contexta*, with a complete Platonic text and annotated editions of some of the principal dialogues such as Hug's *Symposion*, Deuschle and Cron's, or Sauppe's *Protagoras*, Deuschle and Cron's *Gorgias*, Wagner's *Phaidon*, Thompson's *Phaidros*, also Riddell's *Apology*.

The Work from 1878 to 1881.

The working of the Greek Seminarium may be illustrated by the following summary of the subjects treated in the last three years.

In 1878–79, the exercises included the analysis, exegesis and criticism of selected tracts of Lucian, and the prosecution of researches into the language of Lucian and the life of the second century, such as Lucian's relation to Herodotus, the Ionism of the *Dea Syria* and the *De Astrologia*, the use of the optative in Lucian, Lucian and Diogenes Laertius, traditions as to the oriental origin of Greek philosophy, the worship of the Syrian Goddess, Lucian's attitude toward religion, and Lucian as a student of art.

In 1879–80, the centre of work was Aristophanes, and the play selected for special study was the *Wasps*. The members of the seminarium were required to present in turn an exegetical and critical commentary of a portion of this comedy, and this work constituted a regular weekly exercise. In order to secure a wider knowledge of the author, cursory readings were also instituted in the other plays, which were in like manner assigned to certain students, charged with the duty of preparing the historical introduction and the analysis. In this way nearly all the members were made acquainted with the bulk of Aristophanes, and some of them followed besides a course of study in the fragments of the comic poets. Among the more elaborate papers, which were the fruit of this work in Aristophanes, may be mentioned the following: On the tropology of Aristophanes; on the genitive case in Aristophanes; on the infinitive in Aristophanes; on the distribution of the *choreutai* in the *Wasps*.

In 1880–81, the seminarium was mainly engaged in the study of the Attic orators, especial attention being paid to the development of language and style and to the antique canons of aesthetic criticism. The members were required to furnish in turn exegetical and critical commentaries on select portions of the orators, to prepare historical introductions, to make analyses of speeches and abstracts of rhetorical treatises. Parts of Antiphon, Andokides, Lysias, Isokrates, Isaios, and Demosthenes were studied in this way, and some of the minor orations of the four last named were compared with one another in connection with the *iudicia* of Dionysios of Halikarnassos. Besides this general work, subjects of special study in the orators were assigned to individual members of the seminarium, and an effort was made to insure a personal acquaintance on the part of all the students with the works of all the orators of the Attic canon. Introductory lectures, informal examinations and conferences were also held by the Director at suitable points in the course. Of the investigations which were carried on may be noted: Studies on the nominal periphrases for the verb in Antiphon and Thukydides; on the genuineness of the first Antiphontean oration; on synonyms in Antiphon; on the use of the locative formations, of πρίν, and of ἐπί in the orators; an elaborate statistic of certain syntactical characteristics of Andokides; an inquiry into the influence of technical rhetoric on the ῥήσεις of the Attic drama; special work was also done in Isaios, Lykurgos and Deinarchos.

II. Greek (*for advanced and graduate students*).

1. Professor Gildersleeve will lecture on the *History of Greek Literature*, weekly, for the first three months, and thereafter twice weekly through the rest of the year.

2. Professor Gildersleeve will also conduct a series of practical exercises (at least twenty) in *Greek Prose Composition* and in translating Greek at dictation.

3. Dr. M. Bloomfield will conduct a class in *Comparative Grammar*, with especial reference to Greek.

III. Sanskrit, etc.

The courses in Sanskrit and Zend will be conducted by Dr. M. Bloomfield and will include:

1. Sanskrit Grammar (Whitney's) and interpretation.
2. Reading of Easy Texts.
3. Introduction to the Rig-veda.
4. Advanced Sanskrit, Çakuntala: Gṛhyasûtra.
5. Practical Introduction to Zend.

IV. Latin (*for advanced and graduate students*).

1. Dr. Warren will conduct a *Latin Seminarium* to meet twice weekly for the critical study of Vergil. Special attention will be paid to the literary form, to the dependence of Vergil upon Greek and Latin sources, and to his influence upon contemporary and subsequent poets, as well as upon the prose writers of the silver age. Pedagogical needs will be kept constantly in view, and the seminarium will be open to advanced undergraduates who may propose to become Latin teachers, if they shall be found qualified to profit by the exercise.

Students are advised to provide themselves in advance with some edition of the Commentary of Servius to Vergil, and with Kennedy's annotated edition of Vergil, or Ribbeck's critical edition of the text in three volumes.

2. Dr. Warren will begin in February a series of weekly exercises in the interpretation of *Latin Inscriptions*, especially those of the early period.

3. Dr. Warren will also lecture during the latter half of the year on certain distinctive features in the *Syntax of Early Latin*.

V. Greek (*for undergraduates*).

1. Demosthenes, (Philippic and Olynthiac Orations). *From October to February, four hours weekly.* Professor C. D. Morris.

2. Sophocles, (Ajax). Lyric Selections. *From February to June, four hours weekly.* Professor C. D. Morris.

3. Xenophon, (Hellenica, books i–iii). Lysias, (Select Orations). *From October to February, four hours weekly.* Mr. Nicolassen.

4. Homer, (Odyssey, six books). *From February to June, four hours weekly.* Mr. Nicolassen.

5. In connection with each of the above courses, there will be weekly exercises in *Greek Prose Composition*, and occasional practice in reading at sight, and translating Greek at dictation.

6. Towards the close of the year, Professor Gildersleeve will conduct an advanced class of undergraduates in the *Wasps of Aristophanes*.

7. Professor Morris will conduct two conferences weekly, one, in *Greek and Latin Metres*, with practical exercises in verse composition, if such are desired, the other, in *Greek History*.

Private Reading.—Students having the time are encouraged to pursue parallel courses of private reading under the direction of the instructor. This will be entirely voluntary, but those passing an examination upon such work will be able to complete major or minor courses in shorter time than otherwise.

For example, those taking the course numbered 1 above may read Isocrates, *Philippus*, and *Panegyricus*, or Plutarch's *Life of Demosthenes*. Those taking the course numbered 3 may read Xenophon, *Oeconomicus* and *Agesilaus*, or Plato, *Apology* and *Crito*.

VI. Latin (*for undergraduates*).

1. Cicero, (de Natura Deorum, book i). Lucretius, (book v). Catullus, (Selections). *From October to February, seven hours in two weeks.* Dr. Warren.

2. Terence, (Andria, Adelphoe). Plautus, (Captivi). *From February to June, four hours weekly.* Dr. Warren.

3. Quintilian, (book x). Tacitus, (Dialogus de Oratoribus, Agricola, Germania). *From October to February, four hours weekly.* Professor C. D. Morris.

4. Juvenal, (Select Satires). Martial, (Selections). Pliny, (Select Letters). *From February to June, four hours weekly.* Professor C. D. Morris.

5. Livy, (books xxi and xxii, or xxiii and xxiv). *From October to February, four hours weekly.* Mr. Nicolassen.

6. Horace, (Select Odes, Satires, Epistles.) *From February to June, four hours weekly.* Mr. Nicolassen.

7. In connection with each of the above courses, there will be weekly exercises in *Latin Prose Composition*, and occasional practice in reading at sight, and translating Latin at dictation.

Private Reading.—Students having the time are encouraged to pursue parallel courses of private reading under the direction of the instructor. This will be entirely voluntary, but those passing an examination upon such work will be able to complete major or minor courses in shorter time than otherwise.

For example, those taking the course numbered 1 may read Cicero, *de Finibus*, book i; *de Natura Deorum*, books ii and iii, and Lucretius, books i and ii. Those taking the course numbered 3 may read Cicero, *de Oratore*, book ii; Tacitus, *Annals*, books iii and iv, and Suetonius, *Life of Tiberius*.

GERMAN.

The courses in German will be under the direction of Mr. Brandt and will include:

I. Advanced Courses (*introductory to Germanic philology*).

Gothic, (Braune's Gotische Grammatik); *Old High German*, (Hahn's Grammar and Braune's Reader); *Middle High German*, (Paul's small and Weinhold's large Grammar, reading of the "Minnesinger").

II. Major and Minor Courses.

1. Major Course: *Middle High German*, two hours weekly one half-year; *Prose Composition* with Krause's Grammatik, once weekly through the year; reading of *Lessing's Prosa, Luther's "An den Adel"* and the principal plays of *Goethe, Schiller* and *Lessing*.

2. Minor Course: Reading of *Humboldt's Prosa*, Goethe's *Götz von Berlichingen, Hermann and Dorothea, Prosa*, etc.; *Exercises and grammar*, once weekly through the year.

ROMANÇE LANGUAGES.

I. Advanced Courses.

Mr. Elliott will conduct the advanced classes, which will take up the study of the *Romance Dialects, Old French, Provençal* and *Wallachian*.

II. Major and Minor Courses.

1. The major course classes will read, with Mr. Elliott, *Old French*, (*Aucassin and Nicolete*, Suchier's edition), and *Italian*, (Dante, *Divina Commedia*). He will also give a course of lectures on *French Phonetics*.

2. The minor course will be conducted by Mr. Marcou. The class will first read Michelet's Life of *Jeanne d'Arc* for a few weeks, and afterwards other authors will be taken up.

III. Special Classes.

1. A special historical course on the Modern French Socialists will be conducted by Mr. Marcou. He will also form a conversation class, which will meet three times weekly.

2. M. Rabillon will give courses of public lectures, *in French*, and will meet, in a private class, students who wish to perfect themselves in the use of oral and written French.

HISTORY AND POLITICAL SCIENCE.

1. The minor course in History will be conducted by Dr. H. B. Adams. It will include a course in *Mediaeval History*, five hours weekly during the first half-year, and a course in *International Law and Diplomatic History*, five hours weekly during the second half-year.

Candidates for this minor course must pass an examination in European and American History. Freeman's "General Sketch," and Doyle's "United States" will serve to indicate the amount of knowledge required. An acquaintance with French and German will be expected of graduate students, and will be required of undergraduates who take the course in International Law and Diplomatic History.

2. Dr. H. B. Adams will also conduct, during the first half-year, classes in the *Sources of Early European History*, one hour weekly, in *Institutional History*, one hour weekly, and in *Italian History*, one hour weekly; during the second half-year, he will conduct a class in *Comparative Constitutional History*, and give a course of public lectures on the *Development of Civil Society and of Internationalism*.

3. Dr. Austin Scott will give a course of public lectures on the *Development of the American Constitution*, beginning about November 1.

4. Mr. R. M. Venable will give twelve public lectures on *Constitutional Law*, beginning in January.

LOGIC, PHILOSOPHY, ETC.

I. Logic.

Mr. Peirce will give two courses on Logic:

1. An elementary course on *General Logic*, deductive and inductive, including probabilities. This course will be designed to teach the main principles upon which correct and fruitful reasoning must proceed; and special attention will be paid to the discussion of the significance and validity of those logical conceptions and maxims which are current in literature and in law.

2. A course upon the methods of science. A sketch of deductive logic and the theory of relative terms will lead to a study of the methods of Mathematics. The theory of chances and errors will next be expounded. Lastly, after the development of the general doctrine of induction and hypothesis, the methods of reasoning in several of the physical and moral sciences will be examined in detail.

II. Philosophy, Etc.

1. Professor G. S. Morris will give class lectures, during the first half-year, on *Ethics* and on the *History of Greek Philosophy*. He will also give a course of public lectures.

2. Dr. G. Stanley Hall will lecture on *Psychology*.

PEABODY INSTITUTE LECTURES, 1881–82.

The following courses of lectures have been arranged by the Trustees of the Peabody Institute, to be delivered during the coming winter:

1. Dr. Edward A. Freeman, of Oxford, England. Six lectures on *Old, Middle and New England*, beginning November 8.
2. Professor W. H. Goodyear, of the Cooper Union, New York. Four illustrated lectures on *Decorative Art*, beginning November 29.
3. Dr. C. S. Hastings, of the Johns Hopkins University. Three experimental lectures on *Electricity and Magnetism*, beginning December 18.
4. Dr. John Van Bibber, of Baltimore. One lecture on the *Human Brain and its relations to Mind*, December 22.
5. George M. Towle, Esq., of Boston. Four lectures on *Bismarck, Gambetta, Gladstone and Beaconsfield*, beginning January 10.
6. Professor D. Cady Eaton, of New Haven. Four illustrated lectures on *Gothic Architecture*, beginning January 24.
7. Professor M. C. Tyler, of Cornell University. Four lectures on the *Pamphleteers, Song-Writers and Satirists of the Revolution*, beginning February 7.
8. Professor W. F. Apthorp, of Boston University. Four lectures on *the Growth of Music*, with musical illustrations, beginning February 21.

COLLEGIATE INSTRUCTION, 1881–82.

Information as to Graduate Instruction is given in other Circulars.

SPECIAL NOTICE.

Young men who desire to enter the Johns Hopkins University for collegiate instruction, either as Matriculates, or as Students in branches preliminary to Medicine, or as Special Students in Mathematics, Chemistry, Languages, etc., are requested to present themselves, with such introductions, written or personal, as they can command, at the President's office, any morning between June 1 and June 4, inclusive, from 9 to 12 o'clock, when arrangements will be made for their examination, and information will be given in respect to classes, terms, lodgings, etc. Those who cannot appear in June may present themselves on Tuesday, September 20.

TIMES OF EXAMINATION.

There are two formal examinations for matriculation, the first from June 6 to June 9, and the second from September 21 to September 24, as follows:

Monday, June 6.		*Wednesday, June 8.*	
LATIN, - - - - -	9—12.	ALGEBRA, - - - - -	9—12.
GREEK, - - - - -	3—6.	GEOMETRY, - - - -	3—6.
Tuesday, June 7.		*Thursday, June 9.*	
GERMAN, - - - - -	9—12.	TRIGONOMETRY, - - -	9—12.
FRENCH, - - - - -	3—6.	ANALYTIC GEOMETRY, - -	3—6.

Wednesday, September 21.		*Friday, September 23.*	
LATIN, - - - - -	9—12.	ALGEBRA, - - - - -	9—12.
GREEK, - - - - -	3—6.	GEOMETRY, - - - -	3—6.
Thursday, September 22.		*Saturday, September 24.*	
GERMAN, - - - - -	9—12.	TRIGONOMETRY, - - -	9—12.
FRENCH, - - - - -	3—6.	ANALYTIC GEOMETRY, - -	3—6.

Candidates may offer some of the subjects for matriculation at the June examinations, and the others in September.

Students resident in and near Baltimore are advised to present themselves at the examination in June, so that if deficient in any study they may prepare themselves in it for the next examination in September. The results of the matriculation examination will be made known June 10 and September 27, at 12 M.

REQUIREMENTS FOR MATRICULATION.

The special requirements for matriculation are as follows:

Latin. Grammar, Prosody and Composition; *Cæsar*, 5 books; *Ovid*, 2500 verses (500 elegiac); *Virgil*, Æneid, 6 books, and Eclogues; *Cicero*, 7 orations; *Livy*, 1 book; *Horace*, Odes, 2 books.

Greek. Grammar, Prosody and Composition; *Xenophon*, Anabasis, 4 books; *Homer*, Iliad, 4 books; *Herodotus*, 1 book; any one drama.

Mathematics. *Arithmetic*, including the Metric System; *Algebra*, Todhunter, 38 chapters; *Geometry, Plane and Solid*, Chauvenet; *Plane Trigonometry*, Chauvenet, 8 chapters; *Analytic Geometry*, Straight Line and Circle in rectangular coördinates, Salmon (Conic Sections) or Howison.

The subjects named, in both Mathematics and Languages, merely indicate the range of the examination. Equivalents are accepted.

The accurate reading at sight of passages previously unseen may render unnecessary the examination in the books above specified.

Candidates who do not intend to pursue a classical course may offer German and French instead of Greek.

The equivalent of a minor course in one of these subjects will be expected, and a good elementary knowledge of the other.

SPECIAL EXAMINATION IN ENGLISH.—All candidates for admission will be expected to satisfy the authorities that, in addition to the studies in Mathematics and Languages required for admission, they have been well trained in the ordinary English branches, including the use of the English language, Geography and United States History.

SPECIAL EXAMINATION IN NATURAL SCIENCE.—Each candidate for admission is expected to offer for examination in some branch of Natural Science. Physical Geography is recommended as within the reach of all. An elementary acquaintance with Botany, Zoölogy, or Natural Philosophy is also desirable.

COLLEGIATE COURSES.

Courses of study are arranged for collegiate students in Mathematics, Physics, Chemistry and Biology; in Greek, Latin, French, German and English; and in History, Political Economy, etc. It is not supposed that any student can follow all these courses, but every one is required to select such a combination as will secure to him a liberal education, founded upon studies in several branches of literature and science. As a rule, each student will have three courses in progress simultaneously with five weekly exercises in each.

The following combinations are suggested (but not prescribed exclusively) as an aid to students in the selection of their courses for the Bachelor's Degree:

1. CLASSICAL, in which Greek and Latin are the main subjects, and a Modern Language, one Philosophical and one Scientific course subordinate; 2. MATHEMATICAL, with Mathematics and Physics as main subjects, and in addition a Modern Language, Chemistry, and one Philosophical course; 3. SCIENTIFIC, in which marked proficiency in Mathematics, and in either Chemistry, Physics or Biology is required, and in addition one Scientific course, one Philosophical, and one in Language; 4. LITERARY, in which the Romance and Teutonic Languages are taken as the main subjects, and Latin and any other two courses, one of which must be Scientific, as subordinate; 5. PRELIMINARY TO MEDICINE, in which the principal studies are Biology and Chemistry, and in addition Physics, a Modern Language, and one Philosophical course; 6. PRELIMINARY TO THEOLOGY, in which Greek and Hebrew are the principal subjects, and one Philosophical and two Scientific courses subordinate; 7. PRELIMINARY TO LAW, in which marked proficiency in History and Philosophy is required, and in addition a Modern Language, and two Scientific courses; 8. PRELIMINARY TO BUSINESS.

SPECIAL COURSE PRELIMINARY TO MEDICINE.

This course is framed to meet the wants of those who intend at a later day to begin the study of Medicine.

The requirements for entrance by non-matriculated students to the course are as follows:

English. Candidates will be examined in the whole of Lounsbury's History of the English Language, and will be required to satisfy the examiner, by means of a written composition, of their ability to express themselves in correct and idiomatic English, properly spelled, punctuated, and divided into paragraphs.

Elementary Mathematics. Arithmetic; Algebra; three books of Euclid, or an equivalent amount of Geometry; Plane Trigonometry, and the use of Logarithms.

The examination in Algebra will be confined to the following: definitions and explanations of algebraical signs and terms; addition, subtraction, multiplication and division of algebraical quantities; ratio, proportion and variation; simple equations involving not more than two unknown quantities.

Latin. Translation of passages from the first four books of Cæsar, *De Bello Gallico*, and of the sixth book of the Æneid; the elements of Latin Grammar, especially Accidence.

Candidates who obtain permission at least a fortnight previously, will be permitted to offer themselves for examination in equivalent portions of other Latin classics than those presented above.

Physical Geography. Guyot's Physical Geography and Huxley's Physiography are recommended as text books.

French and German. In addition to the above subjects, candidates may offer themselves for examination in French and German; those who pass will be excused from attendance upon the instruction in those languages during the subsequent course of study.

The examination in French and German will test the candidate's knowledge of the elements of the Grammar of those languages, and his ability to translate at sight easy passages from prose authors.

Drawing. Some knowledge of Drawing is very desirable; students who are proficient in this subject may omit it from the subsequent course.

Those who wish to follow this course should indicate their intention to do so before the examination begins.

A circular giving the details of the course may be obtained on application.

SPECIAL STUDENTS.

In exceptional cases, young men of collegiate age, who can satisfy a committee consisting of the President and two of the chief instructors that they are sufficiently advanced in character and attainments to be allowed the privilege, and that there is some good reason why they should not offer themselves for matriculation, may be admitted to certain classes.

CHARGES FOR TUITION.

The charge for tuition is eighty dollars per year. A deposit of ten dollars is required from each student. There is an additional fee for material, etc., in the Laboratories.

SCHOLARSHIPS.

A limited number of free scholarships are awarded to young men from Maryland, the District of Columbia, Virginia and North Carolina.

Instructions will be resumed for the next academic year on Tuesday, September 27, 1881.

Baltimore, May 15, 1881.

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

Published here.

American Chemical Journal. Edited by Professor Remsen. *Vol. III. No.* 1. March, 1881.

Article I.—Revision of the Atomic Weight of Aluminum. By J. W. Mallet, F. R. S.

This is the first half of an exhaustive account of the author's work on the subject mentioned. After a brief statement regarding earlier experiments undertaken by Berzelius, Sir Humphrey Davy, Thomson, Dumas, Tissier and others, for the purpose of determining the atomic weight of aluminum, a large number of ingenious and careful new experiments are described. The values now adopted by different writers on chemical subjects vary between 27.26 and 27.5. The mean result of the new experiments is 27.02. Three methods were used.

1st. Ammonium alum was ignited with great precautions and the amount of aluminum oxide, thus formed, was determined.

2d. The amount of silver required to precipitate the bromine from pure aluminum bromide was determined.

3d. A known weight of aluminum was allowed to act on a concentrated solution of sodium hydrate and the amount of hydrogen evolved carefully measured; and in some other experiments, involving the same reaction, the hydrogen, instead of being measured, was passed over cupric oxide and the water, thus formed, weighed.

The result to which the author is led is 27.019 ± .003, or 27.02. This being so near an integer leads to a discussion of the bearing of the final result upon "Prout's law." The author thinks that "not only is Prout's law not as yet absolutely overturned, but that a heavy and apparently increasing weight of probability in its favor, or in favor of some modification of it, exists and demands consideration."

Article II.—New Phenetol Derivatives. By E. J. Hallock.

A description of a few new substitution-products prepared according to well known methods.

Article III. Preliminary Notice of a New Vegetable Coloring Matter. By S. P. Sadtler and W. L. Rowland.

The coloring matter was extracted from "a variety of wood, called *Beth-a-barra*, which had been recently imported from the west coast of Africa." The new substance consists of microscopic plates made up of a series of flat prisms, joined laterally. It has the formula $C_{28}H_{29}O_5$, or possibly $C_{22}H_{28}O_4$, and appears to be related to chrysophanic acid and the chrysarobin which Liebermann and Seidler found to be the chief constituent of gunpowder.

Article IV.—Concerning Phthalimide. By M. Kuhara.

On treating phthalic acid with phosphorus pentachloride it is converted into a chloride which when treated with aqueous ammonia is converted back, for the most part, into phthalic acid. Under some circumstances, however, the nature of which could not be determined, a substance is formed which has the same composition as phthalimide, but differs from it markedly in its properties. It is probably $C_6H_4\left\{\begin{matrix}C(NH)\\CO\end{matrix}\right\}O$. When the chloride of phthalic acid is treated with ammonia gas, it is converted into phthalimide. The experiments described in this paper make the commonly accepted formula of phthalimide appear probable.

Article V.—Researches on the Substituted Benzyl Compounds:—Substituted Benzaldehydes. By C. L. Jackson and J. F. White.

The substances described are parachlorbenzaldehyde, parabrombenzaldehyde, paraiodbenzaldehyde and metabrombenzaldehyde.

Article VI.—On Furfurol and certain of its Derivatives. By H. B. Hill.

On examining "the working of a new process for the manufacture of acetic acid by the dry distillation of wood at a low and carefully regulated temperature," the author noticed that, in the rectification of the crude wood spirit, a yellowish oil passed over with the vapor of water after the more volatile portions had been distilled off. An examination of this oil shewed that it contained a large amount of furfurol which could be isolated in a pure state with little trouble. Starting with the furfurol thus obtained, the author has taken up a careful study of a number of its derivatives, particularly of mucrobromic acid. In this paper the preparation of the acid and that of its salts is first described; then the action of phosphorus pentabromide, acetyl chloride and of bromine.

Article VII.—Chlorobromide of Lead. By M. W. Iles.

Among the furnace products found by the author at the Grant Smelting Co. works, is a peculiar substance which analyses prove to be a chlorabromide of lead, Pb (BrCl). It occurs in several forms, as for example, in pure white, delicate, dendritic plates, not unlike crystals of lead chloride; in long acicular needles; in semi-fused distorted needles having a slightly yellowish tint, and also in entirely fused warty masses. The corresponding silver salt was made and was found to resemble closely Breithaupt's megabromite and Richter's embolite.

Article VIII.—Alkalimetry with Phenol Phthalein as Indicator. By R. B. Warder.

The experiments of the author, as well as those of Luck, show that phenol phthalein may be used to distinguish between alkalinity and causticity.

Brief Review of the most important changes in the Industrial Applications of Chemistry within the last few years, (continued.) By J. W. Mallet.

The special subjects treated in this report are:

1. *Artificial Production of Heat for Domestic Purposes.* 2. *Artificial Production of Light:* a. *Candles;* b. *Liquid illuminants for burning in Lamps;* c. *Illuminating gas.* 3. *Appendix to Production of Heat and Light.—Matches.*

Report on Analytical Chemistry. By H. N. Morse.

Recent improvements in analytical methods as applied to the following substances are discussed: *Oxygen; Ozone; Water; Hydrogen peroxide; Halogens; Nitrogen; Arsenic; Carbon.*

Notes: The Density of Iodine Vapor, by Crafts and Meier; *Ozone*, by Hautefeuille and Chappuis; *Nitrification*, by Hautefeuille and Chappuis; *Picene*, by C. Graebe and J. Walter.

Recent Publications Relating to Chemistry.

Vol. III. No. 2. May, 1881.

Article I.—Revision of the Atomic Weight of Aluminum. By J. W. Mallet, F. R. S.

Conclusion of the paper of which the first half appeared in the last number. The general results of the whole paper were summed up in the abstract of No. 1 (above).

Article II.—On Furfurol and certain of its Derivatives. By H. B. Hill.

Continuation of the paper of the same title in the preceding number. In this instalment the subjects discussed are: the dibrommaleic acid of Kekulé; mucobromic acids with oxidizing agents; decomposition of mucobromic acid by heat; and the action of barium hydrate on the acid.

Article III.—On the Diiodbromacrylic and Chlorbromacrylic Acids. By C. F. Mabery and Rachael Lloyd.

An account of some of the derivatives of the acids mentioned.

Article IV.—On Microlite from Amelia Co., Virginia. By F. P. Dunnington.

The mineral described is found in crystals varying in dimensions from one-tenth to three-quarters of an inch, and in larger crystalline masses of which one was obtained weighing eight pounds. An analysis was made which led to the formula $\left\{\begin{matrix}8(Ca_2Ta_2O_9)+NbOF_3.\\m(CaWO_3)\end{matrix}\right.$ It is essentially a calcium tantalate.

Article V.—On the Conduct of Finely Divided Iron towards Nitrogen. By Ira Remsen.

In examining certain carbon compounds according to the usual method for the detection of nitrogen, the question arose whether if sulphur is present in addition to the nitrogen, the latter can be detected. Certain compounds known not to contain nitrogen were treated with pure finely divided iron and sodium, and a precipitate afterward obtained which indicated the presence of a cyanide. On carrying the experiments further it was found that when iron by hydrogen and certain non-nitrogenous organic substances are heated together with metallic sodium in an atmosphere of nitrogen, a cyanide is readily formed. The nitrogen is thus absorbed and converted into the cyanide much more readily than in the case of any other reaction as yet known.

Brief Review of the most important changes in the Industrial Applications of Chemistry within the last few years, (concluded). By J. W. MALLET.

The subjects treated are: 1. *Materials employed in Washing:* a. *Soap,* b. *Accessory Materials used in Washing.* 2. *Appendix to Washing:* a. *Perfumes.* 3. *Materials for Writing, Printing, etc.:* a. *Paper;* b. *Ink;* c. *Mucilage;* d. *Artists' pigments.*

Recent Progress in Agricultural Science. By H. P. ARMSBY.

The subject taken up in this report is the *respiration of plants.*

Notes: Asbestos Stopper for Combustion Tubes, by J. Fleming White; *Action of Ozone on Germs contained in the Air,* by E. Chappuis; *Quinquivalence of Boron,* by Michaelis and Becker; *Evaporation without Fusion,* by Lothar Meyer; *On the Absorption of Solar Rays by Atmospheric Ozone,* by W. N. Hartley; *On Carboxytartronic Acid and the Structural Formula of Benzene,* by L. Barth; *On the Conduct of Palladium, Rhodium and Platinum towards Illuminating Gas,* by Th. Wilm; *On the Atomic Weight of Platinum,* by K. Seubert.

Recent Publications relating to Chemistry.

Contents of *Vol. III, No.* 3. June, 1881.

Article I.—On the Deposition of Copper on Iron in a Magnetic Field, by IRA REMSEN.

Article II.—Determination of Chromium in Chrome Iron Ore, by H. N. MORSE and W. C. DAY.

Article III.—On Furfurol and certain of its Derivatives, (concluded,) by H. B. HILL.

Article IV.—Dinitroparadibrombenzols and their Derivatives, by W. D. SCHOONMAKER *and* J. A. VAN MATER.

Article V.—On the Molecular Weight of Hydrofluoric Acid, by J. W. MALLET.

Article VI.—Some Double and Triple Oxalates containing Chromium, by F. W. CLARKE.

Article VII.—The Titration of Tartaric, Malic and Citric Acids with Potassium Permanganate, communicated by F. W. CLARKE.

Article VIII.—Relation between Temperature and the Rate of Chemical Action, by R. B. WARDER.

Article IX.— Oxidation of Sulphaminemetatoluic Acid in Alkaline and in Acid Solution, by R. D. COALE and IRA REMSEN.

Article X.— Concerning Mesitylenic Sulphinide, by IRA REMSEN and P. H. BROUN.

Also *Reports, Reviews and Notes,* by R. H. CHITTENDEN, H. N. MORSE, R. B. WARDER and J. W. MALLET.

American Journal of Philology. Edited by PROFESSOR GILDERSLEEVE. Vol. II, No. 5, 1881.

Article I. Verrius Flaccus, (Second paper). By HENRY NETTLESHIP.

The main question raised in this paper is whether the philological writers of the first five centuries of the Christian era have preserved fragments other than those which have survived in the epitomes of Festus and Paulus. The work of Verrius was the first great encyclopædia alphabetically arranged that was known in Roman literature and there is evidence enough that it was largely consulted by the scholars and antiquarians of the first and second centuries—so by Quintilian, by Pliny the Elder, by Velius Longus. Aulus Gellius studied Verrius Flaccus a great deal and in connection with this part of his subject, Professor Nettleship examines the relation of Nonius to Verrius Flaccus, and comes to the conclusion that the numerous coincidences are due to the fact that both writers used the same authorities. Nonius who has been considered the greatest fool in the world of scholars does not, after all, seem to fall much below the standard of an African of the third century A. D. In any case, the important matter is to ascertain what were the sources from which Nonius drew the materials for his lucubrations. The theory which finds most favor among recent scholars is that Nonius copied largely from Gellius, and that the non-Gellian part of his book is patch-work made up out of commentaries; but Professor Nettleship's aim is to make it probable that Nonius did not borrow from Gellius at all, and that there is nothing to show that he had ever read Gellius. They simply drew from the same sources as did also Julius Romanus and Lutatius Catulus. Several of the notes on Vergil in Macrobius are ultimately derived from Verrius Flaccus, a fact which shows that Verrius was one of the earliest scholars who contributed anything to the interpretation of Vergil. At the close of his article Professor Nettleship subjoins a specimen of reconstruction of parts of the first two letters of the *De Verborum Significatu* from notes in writers later than Verrius.

Article II. A Study of Bentley's English. By HENRY E. SHEPHERD.

Bentley's English falls for the most part, according to Professor Shepherd, within a period of change, a period that is distinguished by the expansion of simple, concise English prose and the complete decadence of the ponderous, complicated syntax of the former age. A more vigorous, nervous, energetic English than Bentley's has rarely been produced; and Professor Shepherd in illustration of the peculiarities of Bentley's diction has selected principally from the Dissertation of Phalaris, 1. Expressions that have become obsolete in the literary form of the language, though still current in familiar speech 2. Words that are often regarded in our day as of recent introduction into the vocabulary. 3. Words or expressions frequently stigmatized as "Americanisms," though in many instances survivors of older and reputable usage. 4. Words and phrases employed with a peculiar significance, sometimes archaic, sometimes apparently impressed upon them by Bentley.

Article III. On the Consonant Declension in Old Norse, (First paper). By S. PRIMER.

The article opens with an exposition of the two prevalent theories of original consonant stems or original vowel stems advanced in explanation of the consonant declension in Germanic. The stems are then divided into four groups: 1, the *u-* and *i-* (relatively *-a-* and *-n-*) stems; 2, the names of relationship; 3, the present participles; 4, the *I-* stems, and Group *I* carefully considered and compared with the same words in the sister languages. The vital question between these two conflicting theories is the umlaut, *i. e.* whether it was caused by the *a* of the ending *-as* or whether it is due to the fact that these stems were once *u-* and *i* stems. In order to get at the truth of the matter it was necessary to examine historically the inner development of the *u-* and *i-* stems in Old Norse, Old English and Old Frise. The first part of the investigation breaks off in the midst of this examination which will be continued in the second part.

Article IV. On the Enclitic Ne in Early Latin. By MINTON WARREN.

The aim of the writer is set forth in the opening paragraph, viz: to show that the enclitic *ne* in early Latin was not confined to questions, and to establish a probability in favor of the existence of two particles *nĕ* distinct in origin and signification. Fourteen passages from Plautus, Terence and Ennius are then discussed in which *ne* is found in the MSS. where the sense either does not require or does not admit of an interrogation. In eight of these passages most of the editors have removed *ne*, *e. g.* in Adelph, 770, *Tun si meus esses. . . .* The writer proceeds to show that Priscian distinctly recognizes an affirmative *nĕ*, for which he has been undeservedly ridiculed by Hand. The evidence of old glosses collected by the writer in Paris, St. Gall and Berne is then adduced, and the interpretation of *nĕ* by *enim, ergo, vero, usque* and *etiam* shown to rest upon good grammatical tradition. The existence of a negative *nĕ* in such expressions as *dixin* = *nonne dixi* is distinctly admitted, but for the *ne* in *egone, tune,* etc., an affirmative origin is claimed. Supported by the close relations of this *nĕ* to *enim* and *nempe* and by the compound *nemut* in a gloss of Festus, the writer posits a pre-Plautine *nem* as the original form of *nĕ*. Finally two possible instances of survival of the form *nim* are cited, Trin., 922, and Merc., 767.

The *Reviews and Book Notices* contain articles on Dellbrück's *Grundlagen der griechischen Syntax,* Enthoven's *Dissertation on the Ion of Euripides,* Timayenis' *History of Greece,* Paul's *Mittelhochdeutsche Grammatik* and Weinhold's *Kleine mittelhochdeutsche Grammatik,* Carpenter's *Grundriss der neuisländischen Grammatik,* Ward's *English Poets,* Mallery's *Collection of Gesture-signs and Signals of the North American Indians,* Pratt and Leaf's *Story of Achilles,* Hart's *Syllabus of Anglo-Saxon Literature,* and Gummere's *Anglo-Saxon Metaphor.*

Reports are given of Kölbing's *Englische Studien*, *Journal Asiatique*, *Rheinisches Museum*, *Philologus*, *Neue Jahrbücher für Philologie u. Paedagogik*, *Archiv für mittel- und neugriechische Philologie.*

List of *Recent Publications.*

No. 6 (being the second number of Vol. II) of the American Journal of Philology will contain:

The first article of Professor Short's series on the *Revision of the New Testament*, (a preliminary statement as to the condition of the Greek and of the English text.)

The conclusion of Dr. Primer's essay on the *Consonant Declension in Old Norse.*

An unpublished Icelandic poem, (*Fable of the Fox*,) edited by Dr. W. H. Carpenter.

A statistic of the use of *Mie* in Old French, by Mr. B. F. O'Connor.

Notes by Dr. S. Garner, Professor M. W. Humphreys, Mr. A. D. Savage, and Professor Shepherd.

Reviews, *Book Notices*, *Recent Publications.*

Studies from the Biological Laboratory. Edited by Professor Martin. *Vol. II. No.* 1.

Article I.—A Contribution to the Study of Induced Keratitis. By William Councilman, M.D. With one colored plate.

(Reprinted from the Journal of Physiology. Vol. III, No. 1.)

The author gives the result of an extended series of histological observations made on inflamed corneas and shews that in the primary destructive processes the "wandering cells" found in the lymph channels play the main part; while in the subsequent regeneration it is the proper corneal corpuscles which are the active elements. These latter multiply by division around the zone where the inflammation has destroyed the cornea and build up the new tissue.

Article II.—Some further Observations on Heat Dyspnœa. By Christian Sihler, M.D., Ph. D.

(Reprinted from the Journal of Physiology. Vol. III, No. 1.)

In this paper the author gives an account of further experiments on this subject, (see Studies from the Biological Laboratory, Vol. I, No. 2). He shews that the hurried respirations which result from exposure to a warm temperature are not mainly, if at all, due to a direct action of warm blood on the respiratory centre, as has been maintained by Goldstein and very generally accepted, but are due to a stimulation of peripheral sensory nerves, either by the warm air acting on the skin, or the warm blood flowing through various organs.

Article III.—The Influence of Quinine upon the Reflex Excitability of the Spinal Cord. By W. T. Sedgwick, Ph. D.

(Reprinted from the Journal of Physiology. Vol. III, No. 1.)

The experiments, made on frogs, were undertaken with the special view of settling how quinine acts in depressing the reflex excitability; whether by exciting the so-called "centres of Setschenow" (whose existence had been made doubtful by the work of various experimenters, though still perhaps generally accepted,) or in some other manner. The conclusion arrived at is that no support of Setschenow's theory can be drawn from the action of quinine, which exerts its influence by stimulating sensory fibres, chiefly in the vagi, and is therefore comparable in its action to the well known reflex depressing influence of powerful stimulation of an afferent nerve.

Article IV.—The Early Development of the Wolffian Body in Amblystoma punctatum. By S. F. Clarke, Ph. D. With three plates.

The conclusions arrived at are that the method of development of the urino-genital system in this form is quite different from that in allied genera, but in many respects resembles that occurring in the Elasmobranch Fishes, though differing from it in others.

Article V.—Notes on the Formation of Dentine and Osseous Tissue. By Christian Sihler, M. D., Ph. D. With one colored plate.

The paper deals with a number of points of detail on these subjects, concerning which there are important differences among prominent histologists, and endeavors, by the use of new methods of working, to determine which view is the more correct in each case. The results arrived at do not readily admit of statement in a brief abstract.

Article VI.—The First Zoea in Porcellana. By W. K. Brooks, Ph. D., and E. B. Wilson, Ph. D. With two plates.

This paper is based on the study of the eggs of a female of *Porcellana ocellata*, obtained at the Marine Station of the University last season. The eggs were kept alive until they hatched, and then the larvæ carefully watched and their successive stages of development studied. The form and number of the appendages present many points of great morphological interest.

Article VII.—The Study of Human Anatomy Historically and Legally Considered. By E. M. Hartwell, Ph. D.

This article is based on papers published by the author in the Journal of the American Social Science Association, the Boston Medical and Surgical Journal, and the Brooklyn Annals of Anatomy and Surgery, but in its present form contains much new matter. It gives a general account of the history of the study of human anatomy and of legislative enactments with respect to it; and in more detail treats of the same topics with reference to the United States.

Article VIII.—On the Rhythmic Nature of Segmentation. By W. K. Brooks, Ph. D. With one plate.

The author calls attention to the fact that the segmentation of an ovum is not a continuous process, but long periods of rest alternate, in many cases, with brief periods of activity, during which great morphological changes occur. He describes in detail the process as observed in the ovum of an osseous fish, and suggests that the explanation of this intermittence is to be sought in the expenditure of energy taking place during each epoch of cell division, which necessitates a time of rest, during which assimilations may occur, before further activity can be manifested.

Article IX.—A New Method of Studying the Mammalian Heart. By H. Newell Martin, M. D., D. Sc., M. A. With one plate.

The author describes in detail a method of physiologically isolating the mammalian heart from all of the remainder of the body but the lungs, and keeping it alive for several hours under conditions permitting of a ready observation of the influence upon it of varying temperatures, varying arterial pressures, different drugs, etc., etc. The mammalian heart can thus be studied almost as thoroughly as the frog's heart has hitherto been.

Article X.—The Processes occurring during the Secretory Activity of the Pepsin-Forming Glands of the Frog. By H. Sewall, Ph. D.

The author concludes that a large amount of secretion may be caused to appear in the stomach of the frog without a corresponding histological change in the œsophageal glands. This secretion is brought about by the injection of certain food materials under the skin. The microscopic changes which the pepsin-forming glands undergo in natural digestion may be started by the absorption of fluid from the rectum alone. The disappearance of granules from the pepsin glands in digestion is probably started by local stimulation of the alimentary canal; the regeneration of the granules depending upon the presence of new building material in the blood itself.

American Journal of Mathematics. Editor in Chief, Professor Sylvester; Associate Editor in Charge, Dr. Story. *Vol. III. Nos.* 3, 4, 1880.

Article I.—A Method of Developing the Perturbative Function of Planetary Motion. By Simon Newcomb.

"The object of the present paper is to exhibit a method of effecting the development in powers of the eccentricities, which seems to me to offer some features of interest, and possibly to contain the germ of some principle which I have not fully grasped, and which may admit of wider and more important applications. I refer especially to the expression of the coefficient of each power of the eccentricity in terms of the coefficients of lower powers, and to the expression of the coefficient of each term involving the perihelia of two planets as the symbolic product of coefficients involving the perihelion of one only. . . . . One great practical advantage of the process is that it is reduced to a uniform operation of algebraic multiplication, which can be executed by an unskilled computer, and can be carried to any extent without repeating the previous processes."

Article II.—On De Morgan's Extension of the Algebraic Processes. By Miss Christine Ladd.

An investigation of the properties of the processes which result from the extension in both directions of the addition and multiplication processes in a sense in which multiplication is an extension of addition. The n-th process is denoted by $\underset{n}{+}$, ordinary addition is $\underset{0}{+}$, and ordinary multiplication is $\underset{1}{+}$. The n-th process is introduced through the logarithmic process, thus:

$$\log.\ ab = \log.\ a + \log.\ b,\ i.\ e.\ \log\left(a \underset{1}{+} b\right) = \log.\ a \underset{0}{+} \log.\ b,$$

and in general

$$\log\left(a \underset{n}{+} b\right) = \log a \underset{n-1}{+} \log b,$$

from which follows

$$a \underset{n}{+} b = \log^{-1}\left(\log a \underset{n-1}{+} \log b\right)$$

and

$$a \underset{n}{+} b = \log\left(\log^{-1} a \underset{n+1}{+} \log^{-1} b\right),$$

the former of which gives the extension to all positive values of n, and the latter to all negative values of n.

The inverses of these processes are also treated, and a number of curious results obtained.

Article III.—On the Motion of a Perfect Incompressible Fluid when no Solid Bodies are Present. By H. A. ROWLAND.

Article IV—On Certain Possible Cases of Steady Motion in an Incompressible Viscous Fluid. By THOMAS CRAIG.

A class of fluid motions is studied for which the quantity

$$\nabla^2 u.\ dx + \nabla^2 v.\ dy + \nabla^2 w.\ dz$$

can be an exact differential. It is shown that for such a case the velocities u, v, w and the components of rotation ξ, η, ζ satisfy the equations

$$u\frac{dP}{dx} + v\frac{dP}{dy} + w\frac{dP}{dz} = 0,$$

$$\xi\frac{dP}{dx} + \eta\frac{dP}{dy} + \zeta\frac{dP}{dz} = 0,$$

and that consequently the stream lines and vortex lines form a network on the surfaces $P =$ const. It is then one of the conditions, under the above assumption, for steady motion in a viscous fluid that there shall exist in the fluid an infinite system of surfaces $P =$ const, each of which is covered by a network of stream lines and vortex lines. Of course this only refers to the part of the fluid moving subject to the condition

$$\nabla^2 u.\ dx + \nabla^2 v.\ dy + \nabla^2 w.\ dz = d\phi.$$

A particular case is studied, viz , the motion of an ellipsoid in a fluid. The resistance is computed for this case and also for the case of a moving sphere by means of a new form for the 'Dissipativity.' The values of the various constants which enter into the problem of the moving ellipsoid are given in terms of elliptic functions.

Article V.—On Binomial Congruences: comprising an Extension of Fermat's and Wilson's Theorems, and a Theorem of which both are Special Cases. By O. H. MITCHELL.

In the first section, the number of numbers less than k containing s and no prime factor of k not found in s is defined as the s-*totient* of k, where $k = a^t b^u \ldots q^z$ and $s = a\,b \ldots l$, and it is designated by $\tau_s(k)$. Any given one of these numbers whose enumeration makes up the s-totient of k is called an s-*totitive* of k, and is denoted by X_s. Unity is included among the values which s can have.

In the second section, $x^2 \equiv x$ mod. k is shown to have 2^i roots, one belonging to each of the 2^i classes of the totitives of k, i being the number of the unequal prime factors of k. These roots are called the *repetents* of k, and any given one is designated by R_s. Certain relations are proved to exist among these repetents, of which the most fundamental are

$$R_s\, R_{s'} \equiv R_{ss'} \text{ mod. } k,$$

$$R_s + R_{s'} \equiv R_{ss'} + R_1 \text{ mod. } k,$$

$$R_{\bar{s}} \underset{\bullet}{+} R_{\bar{s'}} \equiv R_{\overline{ss'}} \text{ mod. } k,$$

where s is prime to s', and $\bar{s}$ denotes the product of all the unequal prime factors of k except those contained in s.

In section three, general forms of Fermat's and Wilson's theorems are given, viz:

$$X_s^{\tau_s(k)} \equiv R^s \text{ mod. } k,$$

and $\Pi_s(k) \equiv \pm R_s$ mod. k, where $\Pi_s(k)$ denotes the product of all the s-totitives of k. When $s = 1$, these become the ordinary theorems, viz:

$$x^{\tau(k)} \equiv 1 \text{ mod. } k,$$

$$\Pi_1(k) \equiv \pm 1 \text{ mod. } k.$$

In the succeeding sections other fundamental theorems in power residues are so generalized as to apply to all numbers, whether prime to the modulus or not. A general expression is given for the number of roots of $x^n - D \equiv 0$ mod. k, and for the whole number of the nth-power residues of the modulus k.

In the last section a theorem is given which includes both Fermat's and Wilson's as special cases. If $k = a^t b^u \ldots l^x \ldots q^z$, $s = ab \ldots l$, $\sigma = a^t b^u \ldots l^x$, and $\Delta =$ any divisor of $\tau_1\left(\frac{k}{\sigma}\right)$, this theorem is

$$\left(X_s'\, X_{ss}'' \ldots X_s^{\left[\frac{\tau_s(k)}{\Delta}\right]}\right)^{\Delta} \equiv R_s \text{ mod. } k;$$

except when $\frac{k}{\sigma} =$ a power of a prime number, double such a power, or $= 4$, and $\frac{\sigma}{s}$ is at the same time an odd number, in which cases the right hand member is $(-R_s)^{Q+1}$, where $Q =$ the number of power residues mod. $\frac{k}{\sigma}$.

$$X_s' \text{ is any root of } X_s^{\Delta} \equiv D_s' \text{ mod. } k,$$

$$X_s'' \text{ is any root of } X_s^{\Delta} \equiv D_s'' \text{ mod. } k,$$

&c., &c. For $\Delta = 1$, this becomes the Wilsonian theorem given above. For $\Delta = \tau_1\left(\frac{k}{\sigma}\right)$, it becomes the Fermatian theorem given above.

Article VI.—Linkages for x^m. By F. T. FREELAND. With a plate.

"By the following method of combining reciprocators (a Peaucellier cell with a modulus one) and bisectors (a pantograph with equal arms) a linkage for x^m may be obtained, m being any positive or negative integer or fraction."

Article VII.—The Strophoids. By W. W. JOHNSON.

A deduction of the equation and some of the geometrical properties of "the locus of the intersection of two straight lines which rotate uniformly about two fixed points in a plane."

Article VIII.—On the Ratio between Sector and Triangle in the Orbit of a Celestial Body. By ORMOND STONE.

"This ratio may be expressed by the formula

$$\frac{1}{\eta} = \frac{rr' \sin (v' - v)}{\sqrt{p\tau}} = \frac{\sin 2\vartheta}{2\vartheta},$$

where the mass of the body is neglected, r and r' are the radii vectores, v and v' the corresponding true anomalies, p the semi-parameter, and τ the product of the intervoning time and the constant of the solar system."

Then, approximately,

$$2\vartheta = \frac{\tau}{(rr')^{\frac{3}{4}}} = \frac{2^{\frac{3}{2}}\tau}{(r+r')^{\frac{3}{2}}}.$$

For a closer approximation

$$\vartheta = \vartheta_0\left(\frac{\cos\vartheta}{\cos\gamma}\right),$$

where $$\vartheta_0^2 = \frac{2\tau^2}{(r+r')^3},\ \cos\gamma = \frac{2\sqrt{rr'}}{r+r'}\cos\frac{1}{2}(v'-v).$$

"This formula includes terms of the same order as those included in Hansen's method, and, if employed in connection with a table giving the logarithms of the ratios between sines and arcs, is rather more convenient."

Article IX.—Centre of Gravity of Surface and Solid of Revolution. By E. W. HYDE.

The quaternion formulae for the centre of gravity of a surface and solid of revolution are

$$\bar{\rho} = \int\left[\vartheta\epsilon^{-1}S\epsilon\phi - \epsilon^{\frac{2\vartheta}{\pi}}V\epsilon\phi\right]_{\vartheta_1}^{\vartheta_2} TV\phi' V\epsilon\phi\,.\,dt$$
$$\div\ (\vartheta_2 - \vartheta_1)\int TV\phi' V\epsilon\phi\,.\,dt$$

and

$$\bar{\rho} = \frac{3}{4}\int\left[\vartheta\epsilon^{-1}S\epsilon\phi - \epsilon^{\frac{2\vartheta}{\pi}}V\epsilon\phi\right]_{\vartheta_1}^{\vartheta_2} S.\,\phi\phi' V\epsilon\phi\,.\,dt$$
$$\div\ (\vartheta_2 - \vartheta_1)\int S.\,\phi\phi' V\epsilon\phi\,.\,dt$$

respectively, where $\rho = \phi(t) = \phi$ is the equation of the generating curve (plane or tortuous) and $\vartheta_2 - \vartheta_1$ is the angle through which it revolves.

Article X.—On a Point in the Theory of Vulgar Fractions. By J. J. SYLVESTER.

The reciprocal of an integer may be called a simple fraction. Any proper fraction may be developed in one way only as a sum of simple fractions each of which has the least possible denominator. Such a determinate development may be called a *sorites*. The present paper has for its object the deduction of some properties of the successive denominators or elements of a sorites, and the actual development is illustrated by numerical examples.

Article XI.—On an Immediate Generalization of Local Theorems in which the Generating Point Divides a Variable Linear Segment in a Constant Ratio. By Samuel Roberts.

"If two curves have a one to one correspondence, and if the points on a particular straight line of one correspond to points on a straight line of the other, the curves are of the same order and deficiency."

"A curve may be determined as the locus of a point, which divides in a constant ratio a terminated straight line variable in length and position; and a family of curves related to one another is obtained by changing the ratio."

"If similar triangles, uniformly directed with respect to the generating segments, be superposed thereon, each having for base the corresponding segment, the general locus of the vertex, say the vertex-curve, is of the same order and the same deficiency as the corresponding ratio-curve."

Some interesting results of this theorem are given.

Article XII.—On the Expansion of $\varphi(x+h)$. By A. W. Whitcom.

The object of this article is to obtain a development for the argument of the remainder in Taylor's theorem.

Article XIII—On the Theory of Rational Derivation on a Cubic Curve. By W. E. Story.

This is a modification and extension of Professor Sylvester's theory, first given in this Journal, Vol. III, pages 58–88, 184–189. The notation has been so modified as to correspond to the usual representation of the points of a cubic by means of a single parameter, the connection of which representation with the theory of total derivation is established.

A number of "totitive" problems are solved, and in a note are contained suggestions for a general notation for "totients." A list of the more important writings on the subject is appended.

Article XIV.—Instantaneous Proof of a Theorem of Lagrange on the Divisors of the Form $Ax^2+By^2+Cz^2$, with a postscript on the Divisors of the Functions which Multisect the Primitive Roots of Unity. By J. J. Sylvester.

In this note is given a short proof that the congruence

$$Ax^2+By^2+Cz^2 \equiv 0 \ (\text{mod. } p)$$

is soluble for every prime modulus p.

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Abstracts of the More Important Papers Read at Recent Meetings.

Scientific Association.

April Meeting.

A Study of Blood Pressure in the Coronary Arteries of the Mammalian Heart, by H. N. Martin and W. T. Sedgwick.

An abstract of this paper is given in University Circular No. 10, page 127.

On a New Method of Studying the Mammalian Heart, by H. N. Martin.

This paper is printed in the Studies from the Biological Laboratory, Vol. II, No. 1. An abstract is also given in University Circular No. 10, page 127.

Some Electromagnetic Experiments with Nickel, by E. H. Hall.

May Meeting.

On the Fixing of Nitrogen by Soils, by W. A. Noyes.

In the spring of 1880, some experiments were undertaken in connection with Professor Merrick, at Iowa College, to determine the effect of varying conditions of light, heat and moisture on the amount of nitrogen fixed by soils. Ten specimens of a soil, previously analysed for total nitrogen and nitric acid, were subjected to various conditions for fifty-seven days, and again analysed. All specimens gained in total nitrogen; only those in direct sunlight gained in nitric acid. The greatest gain was in a soil in diffused light, watered and stirred daily. Both watering and stirring increased the gain of total nitrogen. The very surprising result was obtained that a sample of the soil in a closed fruit jar, exposed to diffused light gained 28 per cent., the greatest gain being only 25 per cent.

Note on the Physiology of the Turtle, by E. M. Hartwell.

This paper gave an account of some investigations into the functions of the spinal nerve trunks of the *Pseudemys rugosa*, or Slider Terrapin, as it is commonly called; the structure of its spinal ganglia; and the anatomy of its sympathetic nervous system. Inasmuch as the spinal nerve trunks are separate from each other, instead of united, as in most Vertebrates, it had been suggested that the ventral and dorsal trunks might be purely motor and sensory in their functions. It was found on experiment that electrical stimulation of the central ends of divided dorsal and ventral trunks alike gave rise to reflex movements in animals rendered insensible by anaesthetics or by cutting the spinal cord just below the medulla oblongata. Stimulation of the peripheral ends of these nerves caused movements in muscles to which the ventral trunks were distributed. No movements resulting from the excitation of the peripheral ends of dorsal trunks had been observed. It was concluded that the ventral trunks contain sensory and motor fibres; and that the dorsal trunks are probably sensory and not mixed in function. Attention was called to the fact that the spinal ganglia contain fibres from both dorsal and ventral roots. Various peculiarities in the structure and arrangement of the sympathetic ganglia were noted. It was stated that experiment had shown that a branch of the middle cervical ganglion of the sympathetic acted as an accelerator nerve of the heart.

On the Action of Nitrogen on Pure Iron, by Ira Remsen.

This paper is printed in the American Chemical Journal, Vol. III, No. 2. An abstract is given on page 144 of this Circular.

June Meeting.

On the Deposition of Copper on Iron in a Magnetic Field, by Ira Remsen.

This paper is printed in the American Chemical Journal, Vol. III, No. 3.

On a Modification of Fechner's Psycho-physical Law in its Application to Vision, by C. S. Hastings.

Philological Association.

April Meeting.

On an Affirmative Enclitic *ne* in Early Latin, by M. Warren.

This paper is printed in the American Journal of Philology, No. 5. An abstract is given on page 145 of this Circular.

On the Ablaut in English, by B. W. Wells of Boston.

This paper attempted to show that the tendency of Old English Strong Verbs to become weak in later periods of the language was the result of fixed principles and due chiefly to the influence of consonants in the stem auslaut; also that the strong forms, where they remained, were for the most part regularly and phonetically developed from the corresponding O. E. forms, exceptions being caused almost solely by a desire for distinctness and simplicity in the ablaut.

On an Alleged Fact in the Life of Euripides, by C. D. Morris.

Attention was called to a statement which is found in the notes of several commentators on Eurip. Hipp. 612, (*ἡ γλῶσσ' ὀμώμοχ', ἡ δὲ φρὴν ἀνώμοτος*) and the biographies of the poet, that he was formally accused of impiety before the Athenian courts on the ground that by the above line he had given encouragement to perjury. The authority quoted for this statement is a passage in Aristotle's Rhetoric (iii. 15, 8). On examination, however, it appears that this passage affords no support to the inference derived from it. Aristotle, in that chapter, is engaged in pointing out and illustrating various ways in which an orator may get rid of an unfavorable impression or prejudice (*διαβολή*) which exists or is excited against him: and he quotes, as one example, the reply of Euripides when the fact that he had written the above line was alleged against him by his opponent in a law suit. But it is expressly stated that the suit in question was one involving an exchange of properties, technically called *ἀντίδοσις*, in which the oaths of the parties, as to the character and extent of their possessions, were an essential feature, and it was of the utmost moment that no antecedent discredit should attach to the word of either of them. The fact that the verb *κατηγορεῖν* is employed to express the attack made on Euripides by his antagonist does not at all imply that this matter was made the basis of a formal accusation; because, as Bremi says, in comparing the use of *κατηγορεῖν* and *διώκειν*, the former means generally '*conviciis opprobriis atque etiam calumniis aliquem adoriri.*'

May Meeting.

The Akkadian and its Influence on Semitic Languages, by REV. FRANCIS BROWN, of the Union Theological Seminary, New York.

The Akkadian, spoken by the pre-Semitic inhabitants of Babylonia, is an agglutinative language in an advanced stage of development. On the basis of Haupt's "*Akkadische und Sumerische Keilschrifttexte*" it is easy to show that the Sumerian is a dialect of the Akkadian, and it is the Akkadian whose traces are most numerous in the Semitic languages. The Assyrian shows them most clearly. The adoption, from the Akkadian, of the cuneiform characters affected the Assyrian phonology, particularly in causing the almost total disappearance of weak letters. *Aleph* initial, and in a few cases, the consonant *waw*, were probably still heard. The quiescents, as *yodh* and *waw*, sometimes modified the adjacent vowel, and thus had a secondary representation to the eye. North-Semitic phonology, however, was not materially affected by the Akkadian, since the contact was too short. The Semitic vocabulary borrowed much from the Akkadian;—the accompanying changes—consonantal and vocalic—are within tolerably well defined limits. Akkadian influence was felt (to a less degree) in Assyrian morphology, and in style, while its various degrees in other dialects may be expected to throw light on the history of Semitic migrations.

A Defence of "Is Being Done," by G. H. STOCKBRIDGE.

The chief objection urged against this phraseology is that it does not accord with the genius of the English tongue. The history of its rise does not favor the objection. It seems to have been a normal growth. Moreover, an analysis of the phrase indicates its conformity to English usage. The auxiliary *to be* is equivalent both to the German *sein* (*to be*) and the German *werden* (*to become*). *The house is being built*, then, corresponds exactly to *Das Haus wird gebaut*, and means, the house is becoming built, is in process of completion as a structure. Again, the alternative locution, *is doing* or *is building*, rests for its justification on the same grounds as the idiom in question. Side by side with the active verbal noun, there has always existed a corresponding passive, and so if *is doing* be regarded as derived from *is in doing* or *is a doing*, *is being done* may claim its origin from *is in being done* or *is a being done.*

A Review of Guillemard's Hebraisms in the New Testament, by J. M. CROSS.

Historical and Political Science Association.

March Meeting.

The Influence of Geographical Position upon Ideas of the Future World, by ALLAN MARQUAND.

Assuming that beliefs respecting a future world vary with the geographical position of the country in which they arise, many of these beliefs were examined with reference to their content of natural scenery and climate. It was ascertained (1) that among inland peoples are found such beliefs as that of happy hunting grounds, Elysian fields, and gardens; as also reaching heaven by climbing a tree, following a trail, ascending a mountain or crossing a river. Among sea-faring peoples and dwellers by great lakes are found conceptions of happy or enchanted islands, reached by a ferry over the waters. (2) In northern latitudes, the happy country is depicted as one where perpetual summer reigns; the abode of misery is in the midst of ice and snow. In middle latitudes, both heat and cold contribute elements of future torment. In southern latitudes, future happiness is frequently conceived as in a cooler climate, beneath the shade of trees, while the miserable are to suffer from extreme heat. Fire in the abode of torment appears to be an Oriental and comparatively modern belief. (3) Valleys, plains, and mountains have also added special characters to the idea of the future world.

Origin and Development of the Municipal Government of New Amsterdam, by J. F. JAMESON.

The object of this paper was to trace the history of the government of Manhattan under the Dutch, and to show how closely the earlier municipal arrangements and the provisions of the charter finally granted followed the institutions then existing in the cities of the Netherlands. The development of the Dutch municipal institutions from the earliest times to the early part of the eighteenth century was briefly described. At the latter period, the chief municipal officers were a *schout* (at once sheriff and president of the court), two or four *burgomasters*, or administrative officers, and five, seven, or nine *schepens*, or associate judges. The principal legislative body was the old council or senate of ex-magistrates. These either appointed the magistrates directly, or nominated a double list, from which the governor-general of the province chose them. In the details, there was the greatest variety in the different towns, and these peculiarities were long retained, through the conservatism of the Dutch. The city governments had already become very powerful and oligarchical. Municipal taxes were under the entire control of the magistracy.

The origin and character of the Dutch West India Company were described, and its charter was discussed at length. Important inaccuracies in the translation given by O'Callaghan in his History of New Netherland were pointed out, and were shown to have been copied by O'Callaghan from the translation in Hazard. These errors, followed by all subsequent writers, have given rise to an incorrect view of the delinquencies of the Company. During the administrations of May, Verhulst, Minuit and Van Twiller, under the Amsterdam Chamber of the Company, no traces of self-government are found. The Company appointed the Director-General, and the Director-General was the government. The officers assisting him were as much provincial as municipal. In Kieft's time, the Eight Men, and, in the first year of Stuyvesant, the Nine Men, representatives of the commonalty, were infrequently and unwillingly consulted. But the able and energetic remonstrances and appeals for a municipal government, addressed by the Nine Men to the States-General, were at last effective. In 1652, the city of New Amsterdam was incorporated. But Stuyvesant, interpreting the charter in the narrowest manner, for a long time withheld from the *burgomasters* and *schepens* the right of electing the *schout*, the right of co-optation, and the control of the municipal excise. The magistracy gained full powers of self-government only seven months before the capture by the English in 1664.

The city government established by the charter was modelled on those of the Netherlands, though of course simpler. The officers bore the same titles and discharged nearly the same duties. The manner of their election, the judicial and financial arrangements, were the same. Everything goes to disprove the theory, apparently adopted even by Bancroft (II, 806), that the free governments of New Netherland arose from imitation of those of New England. On the contrary, the Dutch burghers followed, to use their own words, "the laudable governments of the Fatherland."

May Meeting.

The Currency Question in the United States, by P. B. MARCOU.

Immigration, by STEWART B. LINTHICUM.

Metaphysical Club.

March Meeting.

J. G. Fichte's "Science of Knowledge," by M. I. SWIFT.

Fichte developed the Idealism latent in Kant. His purpose was to show that we have knowledge of absolute reality, and that this is to be found in the nature of knowledge itself. By knowledge he means pure self-contemplating activity; it returns upon itself and is itself its own object. This is the nature of pure Being, or Universal Spirit. For a science of knowledge there must be found an unconditioned and all-inclusive first principle of knowledge. "I am I," or "Ego = Ego," is such a principle. The affirmation 'I am' is at the basis of all other acts of knowledge.

Fichte develops the activity of an absolutely unconditioned Ego, and by this his Idealism is explained. The world, in itself considered, is nothing: it finds its being in an absolute knowledge, or self, which is God. In this Being there is no duality, no antagonism of matter and spirit, for they are one, namely pure activity. This is not the common empty conception of spirit. Fichte's Idealism does not annihilate the external world. Regarded as existing absolutely, for itself, the world is inexplicable; viewed as activity, or spirit, it becomes intelligible. Our knowledge of Being was gained originally wholly from ourselves; we know ourselves as Being. But we know ourselves as activity, as spirit; we cannot therefore predicate true Being of any thing but Spirit. We read in the external world the forms of our own knowledge, and from this we know that the world can only exist as the expression of a spirit like our own. It then corresponds completely to Being as we know it in ourselves. Matter, in itself, regarded as Being, is meaningless. The warrant of the certainty of our knowledge is that, when viewed as above, it explains what is otherwise incomprehensible. In this knowledge we know God.

Hickok's View of Philosophy, by F. E. Stebbins.

Reason, as essentially self-activity, is the universal *one* involved in the totality of being. A complete psychological analysis rests in the attainment of this unmade, self-evident, self-supporting ultimate. The starting-point and termination of speculation and likewise the dialectical process revealing its universal implication are disclosed in this principle as self-knowing and self-determining. Reason, in distinction from all *abstract* methods, integrates, deals in concrete wholes. Its immediate insight into any experience reads there what was conditional for it. It is not a deduction from experience but an induction from without and so productive of wholly new knowledge. This activity sees in any construction that an intelligent constructing activity must have been as a *prior*. It sees in a constructing activity that *itself* must have been, as overlooking, determining and authoritatively controlling. In place and period it sees space and time as conditional for limitation; in force, the condition for bodies in their places and periods in space and time; in life, the condition for an experience in organic facts; that the condition for human experience in a world of forces and lives and living men is a Personal Creator, who, as source of the universal energy constituting force and life is prior to, and has a being irrespective of space and time; that the experience of mankind in a common space and time could not be except as each took his places and periods from the same forces and lives which filled the common space and time. And not alone does the Reason oversee the activities of distinguishing and defining and connecting; it thoroughly knows itself and sees in itself all reasonable truth. In this insight, *itself* is revealed as ultimate standard in the spheres of art, science and morals. As its own object finite reason knows that the Absolute reason must be, and also that it must be independent source and ruler of the totality of being. Thus in all experience, as symbol, Reason knows the meaning before put into it—the conditions without which the experience could not be; the conditions with which the experience must be if it is, and the conditions which evince a proposed end as sufficient reason. These conditions are not assumptions or pre-suppositions taken because needed and which show nothing for their validity, but legitimate pre-requisites taken because *known à priori* to be in order that experience may be.

April Meeting.

On Relations between Sensations, by C. S. Peirce.

Hegel's *Philosophical Propaedeutic*, by B. C. Burt.

This was "discovered" among Hegel's manuscripts in 1838, by Karl Rosenkranz, and edited by him in 1840. It was written for Hegel's classes while he was rector of the Gymnasium at Nuremberg. It is a relatively popular exposition, in outline, of the main body of his thought. It is divided into three courses, only the first having been entirely written out by Hegel. This course,—On Rights, Morals and Religion—was prepared with great care and possesses an interest more than historic. The other courses are not to be overlooked. Translations are given in the Journal of Speculative Philosophy, Vols. III and IV.

On the Relation of Induction to Hypothesis, by E. W. Davis.

The probability of an $\left\{\begin{matrix}\text{induction}\\ \text{hypothesis}\end{matrix}\right\}$ is increased or diminished, in general, by increasing or diminishing the number of $\left\{\begin{matrix}\text{subjects}\\ \text{predicates}\end{matrix}\right\}$ compared.

Since the order of reasoning in induction is case, result, rule, and in hypothesis precisely the reverse, rule, result, case; it follows that what appears as $\left\{\begin{matrix}\text{induction}\\ \text{hypothesis}\end{matrix}\right\}$ when time is reckoned positively, becomes $\left\{\begin{matrix}\text{hypothesis}\\ \text{induction}\end{matrix}\right\}$ if we conceive time to be reckoned negatively.

Straight Lines and Parallels, by J. B. Peterson.

May Meeting.

Logical Machines, by Allan Marquand.

Cunynghame's Syllogistic Cylinder, Stanhope's Demonstrator and the machines of Jevons and of Venn were described. Logical cards were offered as a substitute for the Logical Slate or Stamp. Diagrams were exhibited for a four-term machine resembling that of Jevons in having thirty-two rods raised or lowered by sixteen keys. It differs in requiring only three operations instead of five, in having a sliding face with slits so arranged as to exhibit a complete analysis of the combinations, in dispensing with springs and levers, and in other particulars of minor importance.

A marked improvement was made upon the machine of Mr. Venn. In place of circles, ellipses, etc., rectangles are used to represent the "compartments" of the universe. A square wire frame work with a wire dividing it into two parts, if allowed to fall on a square surface of the same size, will divide it into two compartments, distinguished as *A* and *a*. A similar frame work falling at right angles to the first will divide each of these, giving the four compartments *AB*, *Ab*, *aB*, *ab*. A 3d and 4th character each require frame works with two dividing wires; a 5th and 6th character require four such wires; in general, counting characters by couples, each of the *n*th couple will require a frame work with 2^{n-1} dividing wires. On this principle machines for any number of logical terms may be constructed much more easily than has yet been supposed.

The External World, by J. B. Peterson.

Berkeley and his followers deny that we have any knowledge except of the phenomena of our own minds, and maintain that our belief in a world external to ourselves is an illusion. But this theory is liable to two objections, either one of which is fatal to it. In the first place, it belies the testimony of consciousness, which affirms that material objects are not within the mind but without it. Secondly, it contradicts itself, since it assumes the human body and its sense-organs as external realities.

The question whether there is a world external to ourselves is one that ought never to have been raised; but the question what we know of that world and how we know it, is one of the highest importance, and the knowledge is probably given us in the first instance, in the consciousness of our own limitation.

On the Validity of Induction, by B. I. Gilman.

In this paper three theories of the subject were referred to and criticized, viz: that founded on Laplace's principle of inverse probabilities; that of Mill, founded upon the Law of Causation; and that of Mr. Peirce, founded upon the material view of probabilities and the theory of the adaptation of mind to the universe.

Mathematical Seminary.

April Meeting.

On the Multisection of the Roots of Unity, by J. J. Sylvester.

If p be a prime number, e a divisor of $p-1$, and the e periods into which the primitive p^{th} roots of unity may be distributed are the roots of $\eta^e + B\eta^{e-1} + \ldots$, I call this last written function (say E), the e-period function to p. Every divisor of such function, it is well known, if not p itself or an e^{th}-power residue of p, must be a divisor of the discriminant of E.

Every divisor q of the discriminant is necessarily a divisor of E but may or may not be, according to circumstances, an e^{th}-power residue to p; if it is not, then q may be called an exceptional divisor of the period-function.

When $e=2$ the discriminant is p itself so that (as is well known) there are no exceptional factors to the two-period function. When $e=3$, it may be shown that every factor of the discriminant is necessarily a cubic residue of p.

This may be proved by the Law of Reciprocity for cubic residues, although obtained in quite a different manner. It follows that the three-period function has no exceptional divisor.

When $e=4$ it is better to distinguish between the two cases of $p=8i+1$ and $p=8i+5$.

In the former case 2 is not necessarily a biquadratic but may be only a quadratic residue of p, although a divisor of the 4-period function, and consequently 2 may be an exceptional divisor. When $p=8i+5$, if $p=f^2+4\gamma^2$, every divisor of γ is necessarily a divisor of the function inasmuch as γ is contained in the discriminant, but whilst divisors of γ of the form $4i+1$ are biquadratic, those of the form $4i-i$ will be only quadratic and not biquadratic residues of p. The results for $e=4$ so far as yet stated may be proved by the law of reciprocity for biquadratic residues.

But when $p=8i+5$, or in other words, when $p=f^2+4\gamma^2$ where γ is odd, it may be shown that $\frac{8p^2+f^2}{16}$ is also that factor of the discriminant which is represented by $(\eta_0-\eta_1)(\eta_1-\eta_2)(\eta_2-\eta_3)(\eta_3-\eta_0)$, ($\eta_0$, η_1, η_2, η_3 being the 4 periods taken in natural order), and it is capable of proof that every divisor of this chain of products cannot but be a biquadesidue to p,* or in other words, every divisor of $\frac{f^2+4\gamma^2}{4}$ is a ratic residue of $f^2+4\gamma^2$ when this last quantity is a prime num- This theorem, deduced from the method applied to the divisors of functions, does not appear to be referable to any known theorem ing biquadratic residues. Professor Sylvester finally stated that under consideration the question of the existence or otherwise of onal factors to the e-period function in the general case of e being e number.

Rule of Signs in Determinants, by H. M. Perry.

m columns of a determinant may be substituted without changing rder for the m first columns, (the columns they replace being advanced) by

$$\Sigma j - m - \frac{m(m-1)}{2}$$

ons. Σj is the sum of the indices of the columns.

nilar formula holds for the rows, and the total number of inver- quired to bring any minor to the upper left hand corner is

$$\Sigma i + \Sigma j - 2m - m(m-1).$$

first two terms only affect the sign, and the expanded determinant be written

$$\Delta = \Sigma(-1)^{\Sigma(i+j)} M M^1,$$

M^1 are complementary minors. $\Sigma(i+j)$ is the sum of the indices r minor, since

$$(-1)^{\Sigma(i+j)} = (-1)^{\Sigma(n-i+n-j)}.$$

the rows retain their order

$$\Delta = \Sigma(-1)^{\left(\frac{m(m-1)}{2}+\Sigma j\right)} M M^1,$$

m is the order of the minor in the first rows.

plying the above formula it is only necessary to count the number indices in one minor. The same formula is applicable in alternate rs.

es, by F. Franklin.

On *Newton's method of approximation*. Suppose the equation 0 has one and only one root comprised between a and b; then 's conditions that Newton's method of approximation should lead root are that neither $f'(x)$ nor $f''(x)$ should vanish between . It is easily shown, however, that the first condition is super- it is sufficient that $f''(x)$ should not vanish in the interval. It is also very easily seen that a superior limit to the error after the first approximation is $\pm\frac{1}{2}\frac{F''}{f'(a)}(b-a)^2$, where a is that one of the quantities a, b from which the approximation has to start, and F'' the arithmetically greatest value which $f''(x)$ assumes as x passes from a to b. This limit is more accurate than the one given in Serret's *Cours d'Algèbre Supérieure* and there obtained by a long and rather difficult process.

2). *On a determinant expression for the number of terms in a zero-diagonal determinant, etc.*

8). *On the length of a continued fraction, etc.*

On a Notation for Totients, by W. E. Story.

[See "Note on Totients" appended to an article "On the theory of rational derivation on a cubic curve" in the fourth number of Volume III of the Amer. Jour. of Math.]

The (first) *totient* of n to the condition κ is the number of integers, not greater than n, which satisfy the condition κ. The *k-th totient* of n to the condition κ is the number of sets of k numbers, neither greater than n, which satisfy the condition κ. The first and k-th totients of n to the condition κ are represented by $\overset{n}{\underset{1}{T}}[\kappa]$ and $\overset{n}{\underset{1}{T}}[\kappa]^k$ respectively.

$[\kappa]$ is a number satisfying the condition κ,
$[\bar{\kappa}]$ " " not satisfying the condition κ,
$[\kappa]^k$ is a set of k numbers *each* satisfying the condition κ,
$[\bar{\kappa}]^k$ " " " *neither* " " " ,
$[\overset{\cup}{\kappa}]^k$ " " " *some* " " " ,
$[\overset{\cup}{\bar{\kappa}}]^k$ " " " *not all* " " " ,
$[\kappa.\chi]$ is a number satisfying both the conditions κ and χ,
$[\kappa,\chi]$ " " " one or other of the conditions κ and χ,

$\hat{n}$ denotes some (any) factor of n,

$\hat{n}$ in a set of k numbers denotes some (any) factor of n common to all the numbers of the set,

C denotes "contains as a factor," $\bar{\mathrm{C}}$ denotes "does not contain as a factor." These symbols are to be followed by the numbers contained or not contained.

Several applications of this notation were given. The number of sets of k numbers, neither greater than n, all containing some common divisor of n satisfying the condition κ, but not all containing any one divisor of n satisfying the condition χ (different permutations of k numbers counting as different sets), is

$$\overset{n}{\underset{1}{T}}\left[\mathrm{C}\,(\hat{n}.\kappa).\ \overset{\cup}{\bar{\mathrm{C}}}\,(\hat{n}.\chi)\right]^k$$
$$= n^k \frac{1}{\delta^k}\frac{1}{\delta'^k}\frac{1}{\delta''^k}\cdots\left(1-\frac{1}{\delta_1^k}\right)\left(1-\frac{1}{\delta_1'^k}\right)\left(1-\frac{1}{\delta_1''^k}\right)\cdots,$$

where $\delta, \delta', \delta'', \ldots$ are the *least* divisors of n satisfying the condition κ, and $\delta_1, \delta_1', \delta_1'', \ldots$ are the *least* divisors of n satisfying the condition χ. By a set of *least* divisors is meant a set of divisors no one of which is a multiple of any other.

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uppose q, a prime-number divisor of the "chain-product," to be not a biquad- due of p; then if q is a quadratic residue of p, it may be shown that q must be risor of $(\eta_0-\eta_2)^2(\eta_1-\eta_3)^2$ and therefore of $p\gamma^2$, which is impossible because γ is f and p, and if q is a non-quadratic residue of p, it may be shown that all four roots ngruence, which expresses that the 4-period function contains q, must be equal to her, which admits of easy disproof. Hence q cannot but be a biquadratic residue

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Death of William Hopkins, Secretary of the Board of Trustees.

lliam Hopkins, a retired merchant and a first cousin of the late Hopkins, died in this city today in his 67th year. He was a son ard T. Hopkins, and a member of the society of Friends. * * * opkins was long a member of the firm of T. W. & G. Hopkins. rling integrity and sound judgment, which he never allowed any er influence to warp, secured him the confidence and respect of the business community, and his opinion on matters of business was ought for. He was a trustee of the Johns Hopkins University and ns Hopkins Hospital, and a director in the Farmers and Planters' nd the Maryland Fire Insurance Company."

The Sun, Baltimore, May 28, 1881.

INUTE ADOPTED AT A MEETING OF THE BOARD OF TRUSTEES.

meeting of the Board of Trustees, June 6, 1881, the following was presented and adopted:

he President of the Board be requested to communicate to the brothers and f Mr. William Hopkins, late the Secretary of the Board, an expression of the which his former colleagues entertain for his upright and honorable character aithful attention to the duties of a Trustee in this University, and also of their y with the family in this bereavement.

BRIEF ANNOUNCEMENTS.

Benjamin C. Burt, Fellow in Philosophy, has been appointed Assistant Professor of English and Rhetoric in the University of Michigan.

Edwin H. Hall, Ph. D., late Fellow, and Assistant in the Physical Laboratory here, has been appointed Instructor in Physics at Harvard University.

Mr. Sidney Lanier, Lecturer on English Literature, will give readings in the less familiar Plays of Shakespeare, early in the next academic year.

At a meeting of The Physical Society of London, May 14, 1881, a communication from Professor Rowland and Dr. E. L. Nichols on *Electric Absorption in Crystals* was read by Professor Foster.

According to the theory of Clausius, Maxwell, and others, there should be no electric absorption in the case of perfectly homogeneous substances. Professor Rowland tested this deduction in the case of glass—which is not quite homogeneous—quartz and calcite. This was done by placing the material as the dielectric in a condenser formed of two amalgamated copper plates. The condenser was charged by six Leyden jars, and the absorption measured by a quadrant electrometer. The results were that quartz had about one-ninth the absorptive power of glass, and calcite none at all, a fact which makes it useful for the construction of standard condensers.—*The Electrician*, London, May 21, 1881.

HONORS, Publicly Announced June 6, 1881.

Fellows.

The appointments of Fellows and Fellows by Courtesy were announced as given on page 138.

Doctors of Philosophy.

The degree of Doctor of Philosophy was conferred upon the following persons:

1. Louis Bevier, of Marbletown, N. Y., A. B., Rutgers College, 1878. His principal study has been Greek, the subsidiary, Sanskrit, (in which he was examined by Professor C. R. Lanman, now of Harvard University), and Latin. He submitted a thesis "On the Genuineness of the First Antiphontean Oration."

2. R. Dorsey Coale, of Baltimore. His principal study has been Chemistry, the subordinate, Physics. His thesis, "On Sulphamine- and Sulphoisophthalic Acids," has been printed, in modified form, in the *American Chemical Journal*, (vol. iii, no. 3.)

3. Edward A. Fay, of Washington, D. C., A. B., University of Michigan, 1862, and A. M., 1865. His principal study has been the Romance Languages, (including Old French, Provençal, Italian, Spanish, Portuguese, Wallachian, and Low Latin,) the subordinate Latin. His thesis, "On the Conditional Relations in the Romance Languages," was submitted to Professor Austin Stickney, of New York, formerly of Trinity College, Hartford.

4. Lawrence B. Fletcher, of Marlboro, N. Y., A. B., Columbia College, 1877, and A. M., 1880; (Fellow of Columbia College, 1877–80.) His principal study has been Physics, the subordinate Chemistry. He submitted a thesis "On the Determination of the Mechanical Equivalent of Heat by Electrical Means," which was referred to Professor John Trowbridge of Harvard University, and will shortly be printed.

5. Samuel Garner, of Annapolis, A. B., St. Johns College, 1871. His principal study has been the Romance Languages (including Old French, Italian, Spanish, Portuguese, Provençal, Wallachian and Low Latin,) the subordinate, German. He submitted a thesis on "The Gerundial Construction in the Romance Languages," which was examined by Professor F. Stengel, of Columbia College.

6. Edward M. Hartwell, of Littleton, Mass., A. B., Amherst College, 1873, and A. M., 1876. His principal study has been Animal Physiology, the subordinate, Animal Histology and Animal Morphology. He submitted a thesis, "Notes on some points in the Anatomy and Physiology of the Slider Terrapin, (*Pseudemys rugosa*)," which will be printed in a forthcoming number of the *Studies from the Biological Laboratory*.

7. William T. Sedgwick, of Farmington, Conn., Ph. B., Yale College, 1877. His principal study has been Animal Physiology, the subordinate, Animal Morphology and Vegetable Physiology. His thesis, on "The Influence of Quinine on the Reflex Excitability of the Spinal Cord," has been printed in *The Journal of Physiology*, (vol. iii, no. 1).

8. Christian Sihler, of Cleveland, Ohio, Concordia College, 1866; M. D., University of Michigan, 1871. His principal study was Animal Physiology, the subordinate Animal Morphology and Chemistry. His thesis on "The Formation of Bone and Tooth" was submitted to Dr. George A. Otis, of the U. S. Surgeon-General's Office, Washington.*

9. Edmund B. Wilson, of Geneva, Ill., Ph. B., Yale College, 1878. His principal study has been Animal Morphology, the subordinate Animal Histology, and Animal Physiology. His thesis, on "The Origin and Significance of the Metamorphosis of Actinotrocha," has been printed in the *Quarterly Journal of Microscopical Science*, (April, 1881).

Bachelors of Arts.

The degree of Bachelor of Arts was conferred on the following persons:

1. William W. Baden, of Baltimore, who received his previous training at Steuart Hall, and has finished major courses in Greek and Latin, and minor courses in Chemistry, German, and French.

2. Henry J. Bowdoin, of Baltimore, a former student of Mr. H. W. Luckett, who has finished major courses in German and History, and minor courses in Latin, French, and Physics.

3. John W. Brown, of Govanstown, who pursued his preliminary studies under Mr. G. G. Carey, and has finished major courses in Mathematics and Physics, and minor courses in Latin, French, and German.

4. David T. Day, of Baltimore, who pursued his preliminary studies under Mr. W. S. Marston, and has finished major courses in Chemistry, and German, and minor courses in French, Physics, and English.

5. William H. Howell, of Baltimore, who received his previous training at the City College, and has finished major courses in Biology and Chemistry, and minor courses in Physics, German, and Philosophy.

6. John Johnson, of Owings Mills, a former student of the McDonogh School, who has finished major courses in German and History, and minor courses in French, English, and Physics.

7. James E. Keeler, of Mayport, Florida, who received his previous training at the La Salle (Ill.) High School, and has followed major courses in Physics and German, and minor courses in Mathematics, French, and Chemistry, and has also pursued studies in Astronomy.

8. Edwin G. Richardson, of Baltimore, who received his previous training at the Pembroke School, and pursued studies in Greek and Latin as major subjects, and in History, German, and French as minor subjects.*

9. Adoniram J. Robinson, of Baltimore, a former student of the City College, who has followed major courses in History and Philosophy, and minor courses in Physics, French, and German.

10. Henry Rolando, of Baltimore, who received his previous training at the City College, and has finished major courses in Biology and Chemistry, and minor courses in Physics, French, and German.

11. Lee Sale, of Louisville, Ky., a former student of the Louisville High School, who has finished major courses in Latin and Greek, and minor courses in History, German, and Physics.*

12. Mactier Warfield, of Baltimore, who received his previous training at the Ury House School, Penn., and has finished major courses in Biology and Chemistry, and minor courses in Physics, French, and German.

* The three degrees thus marked were conferred February 22, 1881.

Graduate Scholarships.

Graduate Scholarships, for the coming year, have been conferred upon the following: *

1. William H. Howell, of Baltimore, A. B., Johns Hopkins University, 1881. *Biology.*

2. William D. MacClintock, of Millersburg, Ky., A. B., Kentucky Wesleyan College, 1878. *English.*

3. Chalmers C. Norwood, of Fort Valley, Ga., A. B., Davidson College, 1878. *Mathematics.*

4. William A. Noyes, of Grinnell, Iowa, A. B., Iowa College, 1879. *Chemistry.*

Honorable Mention.

Honorable mention is made of Gustav Bissing, of Baltimore, for superior attainments shown in his examinations in Mathematics.

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* Six graduate scholarships, each yielding two hundred and fifty dollars, in addition to tuition, will be awarded, at the opening of the next academic year, on terms similar to the Fellowships.

JOHNS HOPKINS UNIVERSITY CIRCULARS.

Published with the approbation of the Board of Trustees.

No. 12.] BALTIMORE, DECEMBER, 1881. [PRICE 5 CENTS.

CALENDAR, ACADEMIC YEAR, 1881–82.

September 20.	**Current Academic Year Began.**
September 27.	**Instructions Resumed.**
October 29—December 10.	**M. Rabillon's Lectures on French Literature.**
November 10—17.	**Hon. J. J. Knox's Lectures on Banking.**
November 15—25.	**Mr. E. A. Freeman's Lectures, at the Peabody Institute.**
November 21—25.	**Mr. J. Bryce's Lectures on Some English Problems.**
November 29—December 8.	**Mr. W. H. Goodyear's Lectures, at the Peabody Institute.**
December 13—20.	**Dr. C. S. Hastings's Lectures, at the Peabody Institute.**
December 22.	**Dr. J. Van Bibber's Lecture, at the Peabody Institute.**
December 23—January 3.	**Christmas Recess.**
January 4—February 6.	**Dr. Austin Scott's Lectures on the Development of the American Constitution.**
January 5—March 23.	**Mr. R. M. Venable's Lectures on Constitutional Law.**
January 6—27.	**Dr. G. Stanley Hall's Lectures on Psychology.**
June 9.	**Term of Instruction Closes.**

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MEETINGS OF SOCIETIES.

Scientific. First Wednesday of each month, at 8 P. M. Next meeting, December 7.
S. H. Freeman, Secretary.

Philological. First Friday of each month, at 12 M. Next meeting, December 2.
M. Warren, Secretary.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, December 13.
B. I. Gilman, Secretary.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, December 16.
H. B. Adams, Secretary.

Mathematical. Third Wednesday of each month, at 8 P. M. Next meeting, December 14.
O. H. Mitchell, Secretary.

Naturalists' Field Club. Excursions each Saturday during the Spring and Autumn. Regular meetings for the reading and discussion of papers once a month.
H. F. Reid, Secretary.

2¢ Box

Class B. PROFESSOR C. D. MORRIS. Weekly, Tuesday, 10 A. M., 187 North Howard Street. (7).

Applegarth.
Canfield.
Cromwell.
Duffy.
Lodge.
Walz.
Witzenbacher.

Class C. MR. NICOLASSEN. Weekly, Monday, 9 A. M., Room 5, 193 North Eutaw Street. (18).

Carey.
Garthe.
Glenn, J.
Gregg.
Guard.
Hinkley.
Lord, J. D.
Miller, E. G.
Penniman.
Perkins, W. H.
Robinson.
Stokes, G. C.
Williams.

German. (89 Students.)

Classes meet in Rooms 4 and 5, 193 North Eutaw Street.

Gothic: *Ulfila:* MR. BRANDT. Weekly, Thursday, 9 A. M. (2).

Jagemann.
Thayer.

Middle High German: *Walther von der Vogelweide:* MR. BRANDT. Weekly, Tuesday, 9 A. M. (2).

Bright.
Jagemann.

(*Major Course.*)

German Literature: MR. BRANDT. Alternate Saturdays, 10 A. M. (15).

Bayley.
Crisp.
Duffy.
Fels.
Garthe.
Gittings.
Gordon.
Huggins.
Kemp.
Palmer, A. G.
Penniman.
Prescott.
Stevens.
Williams.
Wilson, H. V.

Schiller: *Prosa:* MR. BRANDT. Twice weekly, Tuesday and Wednesnesday, 11 A. M. (9).

Bayley.
Crisp.
Duffy.
Fels.
Gittings.
Gordon.
Kemp.
Palmer, A. G.
Penniman.

Lessing: *Prosa:* MR. BRANDT. Twice weekly, Thursday and Friday, 11 A. M. (16).

Bayley.
Carey.
Crisp.
Duffy.
Fels.
Gittings.
Gordon.
Hamner.
Hinkley.
Huggins.
Kemp.
Lodge.
Palmer, A. G.
Penniman.
Short.
Williams.

German Prose Composition: (*Class A.*) MR. BRANDT. Weekly, Monday, 11 A. M. (12).

Bayley.
Crisp.
Duffy.
Fels.
Gittings.
Gordon.
Huggins.
Kemp.
Palmer, A. G.
Penniman.
Sieber.
Williams.

(*Minor Course.*)

Humboldt: *Prosa:* MR. BRANDT. Twice weekly, Thursday and Friday, 12 M. (12).

Adkins.
Barnes.
Cole.
Cromwell.
Dorsey.
Duggan.
Haworth.
Hyslop.
Kimball.
MacClintock, J.
Perkins, C. A.
Witzenbacher.

Goethe: *Götz von Berlichingen:* MR. BRANDT. Twice weekly, Tuesday and Wednesday, 12 M. (18).

Adkins.
Cole.
Cromwell.
Dorsey.
Duggan.
Glenn, J.
Hamner.
Hyslop.
Kimball.
MacClintock, J.
Perkins, C. A.
Thomas.
Witzenbacher.

German Prose Composition: (*Class B.*) MR. BRANDT. Weekly, Monday, 12 M. (14).

Adkins.
Carey.
Cole.
Cromwell.
Dorsey.
Glenn, J.
Hinkley.
Hyslop.
Kimball.
Lodge.
MacClintock, J.
Stratton.
Thomas.
Witzenbacher.

Romance Languages. (21 Students).

Classes meet in Rooms B and C, 113 West Monument Street.

Provençal: MR. ELLIOTT. Weekly, Thursday, 5 P. M. (4).

Jagemann.
O'Connor.
Taylor.
Whitelock.

Old French: (*Seminary:*) MR. ELLIOTT. Twice weekly, Mond and Friday, 5 P. M. (5).

Gordon.
Jagemann.
O'Connor.
Taylor.
Whitelock.

Romance Dialects: MR. ELLIOTT. Weekly, Tuesday, 11 A. (4).

Gordon.
Jagemann.
O'Connor.
Taylor.

Italian: *Dante:* MR. ELLIOTT. Twice weekly, Tuesday and Thu day, 12 M. (5).

Crisp.
Garthe.
Gordon.
Jagemann.
Wilson, H. V.

French Phonetics: MR. ELLIOTT. Weekly, Monday 12 (7).

Crisp.
Garthe.
Gordon.
Jagemann.
O'Connor.
Taylor.
Wilson, H. V.

Old French: *Aucassin et Nicolete:* MR. ELLIOTT. Twice week Wednesday and Friday, 12 M. (6).

Crisp.
Garthe.
Gordon.
Jagemann.
Taylor.
Wilson, H. V.

French: *Minor Course:* MR. MARCOU. Daily, 1 P. M. (13).

Friedenwald.
Gittings.
Guard.
Harlan.
Huggins.
Kimball.
Liebig, R. A.
Lodge.
Palmer, A. G.
Ramage.
Rotch.
Stratton.
Walz.

Classes in French Conversation are also conducted by MR. MA and by M. RABILLON.

English. (12 Students).

Classes meet in 187 North Howard Street.

Anglo-Saxon: *Comparative Grammar and Grein's Bibliothek angelsächsischen Poesie:* DR. WOOD. Twice weekly, Wedne and Saturday, 12 M. (1).

Bright.

Anglo-Saxon: *Beowulf:* DR. WOOD. Twice weekly, Tuesday Friday, 12 M. (1).

MacClintock, W. D.

Anglo-Saxon: *March's Anglo-Saxon Reader:* DR. WOOD. T weekly, Monday and Wednesday, 10 A. M. (1).

Jagemann.

Chaucer: *The Prioresses Tale, etc.:* DR. WOOD. Twice wee Monday and Wednesday, 2 P. M. (4).

Fels.
Holstad.
Ramage.
Stickney.

Shakspeare: *Macbeth:* DR. WOOD. Daily, 3 P. M. (6).

Garthe.
Hanser.
Jagemann.
Lord, J. W.
MacClintock, J.
MacClintock, W.
Stevens.

History and Political Economy. (27 Students).

Sources of Early European History: DR. ADAMS. Wee Saturday, 12 M., Peabody Institute. (6).

Bemis.
Gould.
Jameson.
Ramage.
Veblen, T. B.
Wilhelm.

Institutional History: DR. ADAMS. Weekly, Wednes 12 M., Peabody Institute. (5).

Bemis.
Gould.
Jameson.
Ramage.
Wilhelm.

Mediaeval History: DR. ADAMS. Daily, 4 P. M., Room A, 113 West Monument Street. (20).

Berry.
Canfield.
Crisp.
Cromwell.
Dorsey.
Duffy.
Ebeling.
Fels.
Gregg.
Hinkley.
Ingle.
Kimball.
Lord, J. D.
MacClintock, J.
Nicolassen.
Ramage.
Reese.
Stickney.
Tiffany.
Williams.

History of Political Economy: DR. ELY. Twice weekly, Tuesday and Friday, 4 P. M., Room 1, 198 North Eutaw Street. (26).

Bemis.
Berry.
Canfield.
Crisp.
Cromwell.
Dorsey.
Duffy.
Ebeling.
Fels.
Gordon.
Gould.
Gregg.
Hinkley.
Ingle.
Jameson.
Kimball.
Lord, J. D.
MacClintock, J.
Ramage.
Reese.
Stickney.
Swift.
Tiffany.
Veblen, T. B.
Wilhelm.
Williams.

Modern French Socialists: MR. MARCOU. Twice weekly, Tuesday and Friday, 12 M., Room B, 113 West Monument Street. (3).

Bemis.
Gould.
Wilhelm.

History of Philosophy, Ethics, etc. (21 Students.)

Greek Philosophy: PROFESSOR G. S. MORRIS. Thrice weekly, Monday, Wednesday, and Thursday, 11 A. M., 187 North Howard Street. (10).

Burgess.
Giles.
Hanser.
Hobson.
MacClintock, C. T.
MacClintock, W. D.
Sieber.
Spieker.
Swift.
Veblen, T. B.

Ethics: PROFESSOR G. S. MORRIS. Thrice weekly, Monday, Tuesday, and Friday, 12 M., 187 North Howard Street. (4).

MacClintock, C. T.
Prescott.
Swift.
Veblen, T. B.

Psychology: MR. B. E. SMITH. Daily, 1 P. M., Room 8, 198 North Eutaw Street. (7).

Fels.
Gregg.
Leftwich.
MacClintock, C. T.
McDaniel.
Prescott.
Robinson.

A course of lectures by Professor G. S. MORRIS on *Kant's Critique of Pure Reason* is also in progress, weekly, Tuesday, 5 P. M., in Room 5, 198 North Eutaw Street. (Attendance 21).

Logic. (5 Students.)

Classes meet in Room B, 113 West Monument Street.

Advanced Course: MR. PEIRCE. Twice weekly, Monday and Thursday, 8 P. M. (3).

Davis.
Gilman.
Mitchell.

Elementary Course: MR. PEIRCE. Thrice weekly, Tuesday and Friday, 9 A. M.; Wednesday, 10 A. M. (2).

MacClintock, C. T.
Reid.

A course of *Readings in Logic* is also conducted by MR. PEIRCE, weekly, Friday, 4 P. M.

Elocution. (27 Students). MR. WOODWORTH.

Bemis.
Carey.
Cromwell.
Davis.
Dorsey.
Duffy.
Ebeling.
Fels.
Glenn, J.
Guard.
Hamner.
Hinkley.
Hobson.
Ingle.
Keiser.
Leftwich.
Lord, J. D.
Lord, J, W.
MacClintock, J.
Miller, E. G.
O'Connor.
Penniman.
Perkins, C. A.
Ramage.
Rotch.
Stokes, G. C.
Wilhelm.

REGISTER OF NAMES AND ADDRESSES.

The following list gives the addresses of the Officers and Students as now entered at the Registrar's office.

Adams, H. B.	*Associate.*	41 Cathedral St.
Adkins, W. H.	*Matriculate.*	117 N. Charles St.
Alexander, W. J.	*Fellow.*	156 W. Biddle St.
Applegarth, A. C.	**Matriculate.*	632 W. Fayette St.
Armstrong, J. L.	*Graduate.*	Rockville.
Atkinson, T.	*Graduate.*	164 W. Madison St.
Barnes, E.	*Graduate.*	28 McCulloh St.
Bayley, W. S.	*Matriculate.*	641 W. Lombard St.
Beadenkopf, T. M.	*Graduate.*	14 S. Chester St.
Bell, C. J.	*Special.*	48 Cathedral St.
Bemis, E. W.	*Graduate.*	156 W. Biddle St.
Berry, T. A.	*Matriculate.*	247 Bolton St.
Bissing, G.	*Special.*	264 W. Lombard St.
Bland, J. C.	*Graduate.*	Philadelphia.
Bloomfield, M.	*Associate.*	132 W. Madison St.
Brace, De W. B.	*Graduate.*	28 McCulloh St.
Brandt, H. C. G.	*Associate.*	890 Druid Hill Av.
Bright, J. W.	*Fellow.*	38 Linden Av.
Brooks, W. K.	*Associate.*	181 N. Calvert St.
Broun, P. H.	*Graduate.*	119 W. Madison St.
Brown, G. W.	*Trustee.*	89 W. Chase St.
Browne, W. H.	*Librarian.*	2 Huntingdon Av.
Burgess, E. S.	*Fellow.*	180 Linden Av.
Campbell, J. P.	**Matriculate.*	352 N. Eutaw St.
Canfield, W. B.	*Matriculate.*	48 Cathedral St.
Carey, G. G., Jr.	**Matriculate.*	265 N. Eutaw St.
Carpenter, W. H.	*Fellow by C.*	142 N. Charles St.
Caspari, W., Jr.	*Special.*	245 Argyle Av.
Coale, R. D.	*Assistant.*	215 Madison Av.
Cole, T. L.	*Special.*	19 McCulloh St.
Collins, A. T.	*Special.*	Mt. Washington.
Colton, B. P.	*Graduate.*	251 W. Fayette St.
Comstock, W. J.	*Fellow.*	128 W. Madison St.
Conn, H. W.	*Graduate.*	28 McCulloh St.
Converse, J. H.	*Special.*	Bar Library.
Craig, T.	*Associate.*	107 N. Charles St.
Crisp, W. B.	*Special.*	59 Harlem Av.
Cromwell, W. K.	*Matriculate.*	94 W. Lombard St.
Davis, E. W.	*Graduate.*	156 W. Biddle St.
Day, D. T.	*Graduate.*	207 Madison Av.
Day, W. C.	*Fellow.*	207 Madison Av.
Dobbin, G. W.	*Trustee.*	42 St. Paul St.
Donaldson, F.	*Graduate.*	108 Park Av.
Donaldson, H. H.	*Fellow.*	123 W. Madison St.
Dorsey, D. B.	*Special.*	205 Franklin St.
Duffy, H.	*Matriculate.*	82 Townsend St.
Duggan, J. R.	*Graduate.*	54 W. Madison St.
Durfee, W. P.	*Fellow.*	19 McCulloh St.
Ebeling, H. L.	*Matriculate.*	150 N. Eutaw St.
Elliott, A. M.	*Associate.*	142 N. Charles St.
Elliott, J. P.	*Trustee.*	187 St. Paul St.
Ely, G. S.	*Fellow.*	288 Madison Av.
Ely, R. T.	*Lecturer.*	156 W. Biddle St.
Fels, M.	*Matriculate.*	20 Pearl St.
Fleming, W. S.	*Graduate.*	263 N. Howard St.
Franklin, F.	*Assistant.*	228 W. Lanvale St.

Freeman, S. H.	Fellow.	270 W. Fayette St.
Frick, C.	*Matriculate.	400 Park Av.
Friedenwald, H.	*Matriculate.	88 N. Eutaw St.
Gale, H. E.	Graduate.	224 W. Hoffman St.
Garman, H.	Special.	251 W. Fayette St.
Garrett, J. W.	Trustee.	50 Mt. Vernon Place.
Garthe, L.	Matriculate.	98 Hill St.
Gildersleeve, B. L.	Professor.	258 St. Paul St.
Giles, A. H.	Graduate.	214 W. Biddle St.
Gilman, B. I.	Fellow.	142 N. Charles St.
Gilman, D. C.	President.	81 Saratoga St.
Gittings, D. S.	Matriculate.	145 N. Charles St.
Glenn, J., Jr.	Matriculate.	348 N. Eutaw St.
Glenn, W. L.	Matriculate.	158 N. Charles St.
Goodnow, H. R.	Graduate.	209 N. Howard St.
Gordon, B. B.	Matriculate.	27 Franklin St.
Gould, E. R. L.	Graduate.	125 Park Av.
Gregg, M.	Special.	155 N. Charles St.
Guard, W. J.	Matriculate.	150 Park Av.
Gwinn, C. J. M.	Trustee.	85 Mt. Vernon Place.
Hamner, J. G.	Graduate.	185 St. Paul St.
Hanser, O. F.	Graduate.	62 N. Fremont St.
Harlan, W. B.	Special.	247 Linden Av.
Harrison, G.	Graduate.	90 Read St.
Hartwell, E. M.	Fellow by C.	132 W. Madison St.
Hastings, C. S.	Associate.	8 Denmead St.
Haworth, E.	Graduate.	54 McCulloh St.
Hinkley, J.	Matriculate.	287 N. Charles St.
Hobson, B. L.	Graduate.	28 McCulloh St.
Holstad, A.	Graduate.	118 Lexington St.
Hopkins, L. N.	Trustee.	188 St. Paul St.
Howell, W. H.	Graduate.	433 N. Mount St.
Huggins, L. M.	*Matriculate.	St. Paul St. extended.
Hyslop, J. T.	Prelim. Med.	182 Mulberry St.
Ingle, E.	Matriculate.	358 Linden Av.
Jagemann, H. C. G.	Graduate.	255 N. Eutaw St.
Jameson, J. F.	Fellow.	54 McCulloh St.
Keiser, E. H.	Graduate.	28 McCulloh St.
Kemp, G. T.	Matriculate.	55 N. Greene St.
Kimball, R. F.	Matriculate.	87 Park Av.
King, F. T.	Trustee.	76 Cathedral St.
Koyl, C. H.	Fellow.	125 Park Av.
Kuhara, M.	Fellow by C.	284 Linden Av.
Lee, F. S.	Graduate.	92 Saratoga St.
Leftwich, T. J.	Special.	132 W. Madison St.
Liebig, G. A.	Matriculate.	307 St. Paul St.
Liebig, R. A.	Matriculate.	307 St. Paul St.
Linthicum, S. B.	Graduate.	131 W. Lanvale St.
Lodge, G.	Matriculate.	210 N. Gilmor St.
Lord, J. D.	Matriculate.	205 N. Carrollton Av.
Lord, J. W.	Prelim. Med.	205 N. Carrollton Av.
Loudon, W. J.	Graduate.	19 McCulloh St.
MacClintock, C. T.	Graduate.	54 W. Madison St.
MacClintock, J.	Special.	54 W. Madison St.
MacClintock, W. D.	Graduate.	54 W. Madison St.
Mahon, O. L.	Special.	136 N. Exeter St.
Mahon, R. W.	Graduate.	136 N. Exeter St.
Marcou, P. B.	Assistant.	38 Hamilton St.
Martin, H. N.	Professor.	221 St. Paul St.
McDaniel, C. T.	Special.	428 W. Fayette St.
Miller, C. W. E.	Matriculate.	306 S. Sharp St.
Miller, E. G., Jr.	Matriculate.	279 W. Baltimore St.
Mills, T. W.	Graduate.	150 N. Eutaw St.
Mitchell, O. H.	Fellow.	140 Cathedral St.
Moale, W. A.	Graduate.	152 N. Charles St.
Morris, C. D.	Professor.	158 N. Howard St.
Morris, G. S.	Lecturer.	132 W. Madison St.
Morse, H. N.	Associate.	12 Denmead St.
Mumper, W. N.	Graduate.	258 N. Caroline St.
Nelson, K. S.	Graduate.	267 N. Eutaw St.
Newell, H.	Assistant.	Maryland Inst.
Nicolassen, G. F.	Assistant.	600 W. Lombard St.
Norwood, C. C.	Graduate.	263 N. Howard St.
Noyes, W. A.	Graduate.	19 McCulloh St.
O'Connor, B. F.	Fellow.	4 McCulloh St.
Orndorff, W. R.	Special.	13 Lorman St.
Osborn, H. L.	Fellow.	393 W. Lombard St.
Page, J.	Matriculate.	81 W. John St.
Palmer, A. G.	Matriculate.	172 McCulloh St.
Palmer C.	Fellow.	96 Townsend St.
Parrish, N. M.	Special.	336 N. Gilmor St.
Peirce, C. S.	Lecturer.	21 Read St.
Penniman, G. D.	*Matriculate.	117 W. Monument St.
Perkins, C. A.	Graduate.	28 McCulloh St.
Perkins, W. H.	Matriculate.	207 Franklin St.
Perry, H. M.	Fellow.	263 N. Howard St.
Prentiss, R. W.	Graduate.	126 Denmead St.
Prescott, P. M.	Special.	48 Cathedral St.
Price, H. L.	Prelim. Med.	70 Bolton St.
Pund, F.	Special.	232 N. Gay St.
Rabillon, L.	Lecturer.	69 Park Av.
Ramage, B. J.	Graduate.	217 N. Howard St.
Randall T. H.	Special.	865 N. Charles St.
Randolph, R. L.	Prelim. Med.	140 St. Paul St.
Reese, R. M.	Matriculate.	209 W. Pratt St.
Reid, H. F.	Graduate.	75 Mt. Vernon Place.
Remsen, I.	Professor.	218 St. Paul St.
Robinson, L. B.	*Matriculate.	16 Brown St.
Rotch, F.	*Matriculate.	182 W. Madison St.
Rowland, H. A.	Professor.	14 Cathedral St.
Sale, S.	Graduate.	36 N. Stricker St.
Scott, A.	Associate.	
Sedgwick, W. T.	Associate.	284 Linden Av.
Sewall, H.	Associate.	62 W. Madison St.
Short, H. A.	Fellow by C.	20 Cathedral St.
Sieber, J.	Graduate.	178 S. Wolfe St.
Smith, B. E.	Instructor.	54 McCulloh St.
Spieker, E. H.	Fellow.	123 N. Paca St.
Stevens, L. T.	Matriculate.	105 Charles St. Av.
Stewart, C. M.	Trustee.	167 Dolphin St.
Stickney, C. D.	Special.	St. James Hotel.
Stokes, G. C., Jr.	Matriculate.	Govanstown.
Stokes, H. N.	Fellow.	24 McCulloh St.
Story, W. E.	Associate.	87 N. Charles St.
Stratton, W. E.	*Matriculate.	66 N. Liberty St.
Swift, M. I.	Fellow.	218 Linden Av.
Sylvester, J. J.	Professor.	Mt. Vernon Hotel.
Taylor, P. H.	Special.	257 Linden Av.
Thayer, W. C.	Graduate.	132 W. Madison St.
Thomas, H. M.	Prelim. Med.	317 Madison Av.
Thomas, J. C.	Trustee.	317 Madison Av.
Tiffany, H. T.	Matriculate.	85 Bolton St.
Trimble, I. R.	Prelim. Med.	241 Maryland Av.
Uhler, P. R.	Associate.	Peabody Institute.
Veblen, A. A.	Graduate.	129 S. Patterson Park Av.
Veblen, T. B.	Graduate.	197 N. Calvert St.
Venable, R. M.	Lecturer.	87 Franklin St.
Walz, W.	Special.	288 E. Madison St.
Warfield, M.	Graduate.	112 St. Paul Street.
Warren, M.	Associate.	89 Mt. Vernon Place.
White, F.	Trustee.	Gay and Lombard Sts.
Whitelock, G.	Special.	142 N. Charles St.
Wiegand, H. H.	Special.	272 Madison Av.
Wilhelm, L. W.	Graduate.	64 Pennsylvania Av.
Williams, H. W.	Matriculate.	60 Franklin St.
Wilson, E. B.	Assistant.	284 Linden Av.
Wilson, H. V.	Matriculate.	314 Linden Av.
Witzenbacher, W. J.	*Matriculate.	28 McCulloh St.
Wood, H.	Associate.	182 W. Madison St.
Woodworth, C. L.	Assistant.	180 Linden Av.

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.	SATURDAY.
A. M. 9	Chemistry. (Remsen.) Demosthenes. (C. D. Morris.) Latin Prose. (Nicolassen.) Higher Pl. Curves: Adv. (Story.) Total Diff. Equa. (Franklin.) French Conversation. (Marcou.)	Chemistry. (Remsen.) Greek Prose. (C. D. Morris.) Livy. (Nicolassen.) Logic: Elem. (Peirce.) Mammal. Anatomy. (Brooks.) Middle High German. (Brandt.) Solid Anal. Geom.: Elem. (Franklin.) Spherical Harmonics. (Craig.)	Chemistry. (Coale.) Demosthenes. (C. D. Morris.) Livy. (Nicolassen.) Total Diff. Equa. (Franklin.) French Conversation. (Marcou.) Physics: Major. Laboratory work, 9 A. M. to 5 P. M. (Hastings.)	Chemistry. (Remsen.) Demosthenes. (C. D. Morris.) Livy. (Nicolassen.) Mammal. Anatomy. (Brooks.) Gothic. (Brandt.) Higher Pl. Curves: Adv. (Story.) Total Diff. Equa. (Franklin.)	Chemistry. (Remsen.) Demosthenes. (C. D. Morris.) Livy. (Nicolassen.) Logic: Elem. (Peirce.) Higher Pl. Curves: Adv. (Story.) Spherical Harmonics. (Craig.) French Conversation. (Marcou.)	Chemistry. (Coale.)
10	Physics. (Hastings.) Quintilian. (C. D. Morris.) Physiology: Elem. (Sewall.) Anal. Chem. (Morse.) Solid Anal. Geom.: Elem. (Franklin.) Anglo-Saxon: Elem. (Wood.)	Physics. (Hastings.) Greek Exercises. (Gildersleeve.) Latin Prose. (C. D. Morris.) Physiology: Elem. (Sewall.) Quaternions. (Story.) Anal. Chem. (Morse.)	Physics. (Hastings.) Quintilian. (C. D. Morris.) Physiology: Elem. (Martin.) Quaternions. (Story.) Anal. Chem. (Morse.) Anglo-Saxon: Elem. (Wood.) Logic: Elem. (Peirce.)	Physics. (Hastings.) Quintilian. (C. D. Morris.) Physiology: Adv. (Martin.) Mineralogy. (Morse.) Solid An. Geom.: Elem. (Franklin.)	Physics. (Hastings.) Greek Exercises. (Gildersleeve.) Quintilian. (C. D. Morris.) Physiology: Elem. (Sewall.) Quaternions. (Story.) Mineralogy. (Morse.)	German Literature. (Brandt.) (Alternate Saturdays.)
11	Physiology: Adv. (Martin.) German: Major. (Brandt.) Cicero, etc. (Warren.) Greek Prose. (Nicolassen.) Greek Philos. (G. S. Morris.) Calculus of Variations. (Craig.)	General Biology. (Martin.) German: Major. (Brandt.) Latin Prose. (Warren.) Xenophon. (Nicolassen.) Mechanics. (Craig.) Diff. Calculus. (Franklin.) Romance Lang.: Adv. (Elliott.)	General Biology. (Sedgwick.) German: Major. (Brandt.) Cicero, etc. (Warren.) Xenophon. (Nicolassen.) Greek Philos. (G. S. Morris.) Mechanics. (Craig.) Diff. Calculus. (Franklin.)	General Biology. (Sedgwick.) German: Major. (Brandt.) Cicero, etc. (Warren.) Xenophon. (Nicolassen.) Greek Philos. (G. S. Morris.) Calculus of Variations. (Craig.)	General Biology. (Sedgwick.) German: Major. (Brandt.) Cicero, etc. (Warren.) Xenophon. (Nicolassen.) Mechanics. (Craig.) Diff. Calculus. (Franklin.)	
M. 12	Plato: Lect. (Gildersleeve.) German: Minor. (Brandt.) Thermodynamics. (Rowland.) French: Major. (Elliott.) Osteology. (Brooks.) Ethics. (G. S. Morris.)	German: Minor. (Brandt.) Thermodynamics. (Rowland.) French: Major. (Elliott.) French Socialists. (Marcou.) Osteology. (Brooks.) Ethics. (G. S. Morris.) Anglo-Saxon: Adv. (Wood.) Greek History. (C. D. Morris.)	Plato: Seminary. (Gildersleeve.) German: Minor. (Brandt.) Thermodynamics. (Rowland.) French: Major. (Elliott.) History: Adv. (Adams.) Anglo-Saxon: Adv. (Wood.)	Greek Lit. (Gildersleeve.) German: Minor. (Brandt.) French: Major. (Elliott.) Osteology. (Brooks.)	German: Minor. (Brandt.) Thermodynamics. (Rowland.) French: Major. (Elliott.) French Socialists. (Marcou.) Osteology. (Brooks.) Ethics. (G. S. Morris.) Anglo-Saxon: Adv. (Wood.) Metres. (C. D. Morris.)	History: Adv. (Adams.) Anglo-Saxon: Adv. (Wood.)
P. M. 1	French: Minor. (Marcou.) Conic Sections. (Story.) Elliptic Functions. (Craig.) Philosophy: Minor. (Smith.)	French: Minor. (Marcou.) Theory of Numbers. (Sylvester.) Philosophy: Minor. (Smith.)	French: Minor. (Marcou.) Conic Sections. (Story.) Elliptic Functions. (Craig.) Philosophy: Minor. (Smith.)	French: Minor. (Marcou.) Conic Sections. (Story.) Elliptic Functions. (Craig.) Philosophy: Minor. (Smith.)	French: Minor. (Marcou.) Theory of Numbers. (Sylvester.) Philosophy: Minor. (Smith.)	
2	Chaucer. (Wood.)		Chaucer. (Wood.)			
3	Shakspeare. (Wood.) Sanskrit: Elem. (Bloomfield.)	Shakspeare. (Wood.)	Shakspeare. (Wood.)	Shakspeare. (Wood.) Physics: Major. (Hastings.)	Shakspeare. (Wood.) Sanskrit: Elem. (Bloomfield.)	
4	History: Minor. (Adams.) Sanskrit: Adv. (Bloomfield.)	History: Minor. (Adams.) Vergil: Seminary. (Warren.) Political Economy. (Ely.)	History: Minor. (Adams.) Compar. Philol. (Bloomfield.)	History: Minor. (Adams.) Sanskrit: Adv. (Bloomfield.)	History: Minor. (Adams.) Vergil: Seminary. (Warren.) Political Economy. (Ely.) Logic: Readings. (Peirce.)	
5	Romance Lang.: Adv. (Elliott.) Logic: Adv. (Peirce.) (8 P. M.)	Kant: Lect. (G. S. Morris.)	Sanskrit: Elem. (Bloomfield.)	Romance Lang.: Adv. (Elliott.) Logic: Adv. (Peirce.) (8 P. M.)	Romance Lang.: Adv. (Elliott.)	

The public lectures in Hopkins Hall begin at 5 P. M.

UNIVERSITY ROOMS AND HOURS.

Unless otherwise indicated the rooms designated are in the University Buildings, corner of Howard and Ross Streets.

Consultation Hours.

Saturdays and Sundays are excepted.

The President and members of the Academic Staff will receive students and other persons desiring to consult them, at the hours and places indicated in the following schedule.

For the economy of time, on the part both of the Faculty and of the students, it is particularly requested that official consultations be made, except in special emergencies, as appointed below.

President Gilman is seldom absent from the buildings between 9 A. M. and 2 P. M., and is often in his office during the afternoon. Routine business and matters of minor importance may be brought to his attention orally, between 12 and 1 P. M., or at other times by notes and memoranda left with the clerk in the Registrar's office.

Adams, H. B., Associate in History, *Registrar's Office*, 9 A. M., and 5 P. M.
Bloomfield, M., Associate in Sanskrit, *123 W. Madison St.*, 12 M.
Brandt, H. C. G., Associate in German, *Room 5, 193 N. Eutaw St.*, before 11 A. M. or after 1 P. M.
Brooks, W. K., Associate in Biology, *Biological Laboratory*, 10 A. M.
Browne, W. H., Librarian, *Library*, 9 A. M.-5 P. M.
Coale, R. D., Assistant in Chemistry, *Chemical Laboratory*, 10 A. M.
Craig, T., Associate in Mathematics, *187 N. Howard St.*, 12 M.
Elliott, A. M., Associate in Romance Languages, *Room B, 113 W. Monument St.*, 1 P. M.
Ely, R. T., Lecturing on Political Economy, *156 W. Biddle St.*, 11 A. M.
Franklin, F., Assistant in Mathematics, *Room 16*, 12 M.
Gildersleeve, B. L., Professor of Greek, *Room 14*, 11 A. M.
Hastings, C. S., Associate in Physics, *Room 4*, 11 A. M.
Marcou, P. B., Assistant in French, *Room C*, 113 W. Monument St., 1 P. M.
Martin, H. N., Professor of Biology, *Biological Laboratory*, 12 M.
Morris, C. D., Professor (Collegiate) of Greek, *187 N. Howard St.*, 11 A. M.
Morris, G. S., Lecturer on Philosophy, *132 W. Madison St.*, 4 P. M.
Morse, H. N., Associate in Chemistry, *Chemical Laboratory*, 11 A. M.
Nicolassen, G. F., Assistant in Latin and Greek, *Room 3, 193 N. Eutaw St.*, 10 A. M.
Peirce, C. S., Lecturer on Logic, *Rooms B and C, 113 W. Monument St.*, Monday and Thursday, 3 P. M.; Tuesday and Friday 9 A. M.; Wednesday, 10 A. M.
Remsen, Ira, Professor of Chemistry, *Chemical Laboratory*, 11 A. M.
Rowland, H. A., Professor of Physics, *Physical Laboratory*, 9 A. M.
Sedgwick, W. T., Associate in Biology, *Biological Laboratory*, 9 A. M.
Sewall, H., Associate in Biology, *Biological Laboratory*, 12 M.
Smith, B. E., Instructor in Philosophy, *Room 3, 193 N. Eutaw St.*, 2 P. M.
Story, W. E., Associate in Mathematics, *Room 15*, 12 M.
Sylvester, J. J., Professor of Mathematics, *Room 17*, 12 M.
Warren, M., Associate in Latin, *39 Mt. Vernon Place*, 2 P. M.
Wood, H., Associate in English, *187 N. Howard St.*, 11 A. M.
Woodworth, C. L., Instructor in Elocution, *180 Linden Av.*, 6 P. M

Treasurer's Office.

Mr. C. J. Meyer will be in attendance in the Treasurer's Office, in the University Buildings, 9 to 11 A. M., 3 to 5 P. M.

Registrar's Office.

This office is open daily, except Saturdays, from 9 A. M. to 5 P. M., and on Saturdays from 9 A. M. to 3 P. M., and from 4 to 4.30 P. M.

Receipt and Departure of Mails, Etc.

(*Including Saturdays*).

Mails are received from the Post-office at 9 A. M. and 4 P. M.
Mails are sent to the Post-office at 8 A. M., and 3 P. M.
Mails are sent to the Street Letter-Box at 12 M., and 6 P. M.

☞ Memoranda, notes, letters, and parcels may be left at the Registrar's office to be distributed at 9 A. M. and 4 P. M.

Library and Laboratories.

The Library is open daily, including Saturdays, from 9 A. M. to 10 P. M.

The Biological Laboratory is open daily, from 9 A. M. to 5 P. M.

The Chemical Laboratory is open daily, from 9 A. M. to 5 P. M.

The Physical Laboratory is open daily, including Saturdays, from 9 A. M. to 5 P. M.

COURSES IN LOGIC, ETHICS, PSYCHOLOGY, AND HISTORY OF PHILOSOPHY, 1881-82.

I. Professor C. S. Peirce, S.B., A.M., of the U. S. Coast and Geodetic Survey, will give two courses in *Logic*, viz:

(*a*) An elementary course on *General Logic*, deductive and inductive, including probabilities.

This course will be designed to teach the main principles upon which correct and fruitful reasoning must proceed; and special attention will be paid to the discussion of the significance and validity of those logical conceptions and maxims which are current in literature and in law.

(*b*) A course upon the *Methods of Science*.

A sketch of deductive logic and the theory of relative terms will lead to a study of the methods of Mathematics. The theory of chances and errors will next be expounded. Lastly, after the development of the general doctrine of induction and hypothesis, the methods of reasoning in several of the physical and moral sciences will be examined in detail.

(*c*) Professor Peirce will also give a series of *Readings in Logic*, of which the special subjects will be announced from time to time.

II. Professor G. S. Morris, A. M.,

(*a*) will lecture three times weekly, (Monday, Tuesday, and Friday, 12 M.), during the first half year, on *Ethics*.

In this course, various natural types of morality, as illustrated in the life and literature of historic peoples, will be considered; the history of reasoned ethical systems will receive attention; the true method of ethical inquiry will be discussed; and the fundamental notions and principles of ethical theory will be developed.

(*b*) will lecture three times weekly, (Monday, Wednesday, and Thursday, 11 A. M.), during the first half year, on the *History of Greek Philosophy*.

This course will comprise an exposition of the nature, methods and results of philosophic thought, universally, Greek Philosophy furnishing the text and necessary illustrations. Constant reference will be made to the results of modern research in science and philosophy. The philosophy of Aristotle and Plato will be principally considered.

(*c*) will lecture weekly (Tuesday, 5 P. M.) on *Kant's Critique of Pure Reason*.

The main object of this course will be to furnish a summary account of the purport of Kant's "epoch-making" work and a critical estimate of the value of the results therein reached.

The subjects treated are the fundamental conditions and most universal principles of mathematical and physical science; the nature and limitations of the field of objects with which such science is concerned; and the nature and limitations of "metaphysics."

III. Professor G. Stanley Hall, Ph. D., Lecturer in Harvard and Williams Colleges, will give a course of lectures on *Psychology*, beginning early in January. (See p. 167.)

The lectures will discuss the general characteristics of sensations, memory, genesis of the knowledge of time and space, concepts, classifications of psychic activities, the nature and degrees of certainty, morbid psychology, the development of intelligence in children, with general psycho-physic conclusions.

IV. The minor course for undergraduate students in Mental and Moral Philosophy will be conducted through the year by Mr. Benjamin E. Smith, A. M., late Instructor in Amherst College.

October, 1881.

COURSES IN MATHEMATICS AND PHYSICS, 1881-82.

EXPECTED VISIT FROM PROFESSOR CAYLEY.

An invitation has been extended through Professor Sylvester to Professor A. CAYLEY, D. C. L., LL. D., F. R. S., Sadlerian *Professor of Pure Mathematics in the University of Cambridge*, (England), to visit Baltimore and take part in the mathematical instruction of the Johns Hopkins University during the ensuing academic year. Professor Cayley has accepted this invitation, and it is expected that he will arrive in this country before the first of January next, and take a regular part in the instructions of the Johns Hopkins University, from that time until the close of the session in June.

Besides giving lectures to mathematicians, he will, like Professor Sylvester, take part in the Mathematical Seminary and be accessible to advanced students who desire to consult him in the progress of their work.

COURSES AND LECTURES.

PROFESSOR SYLVESTER, LL. D., D. C. L., F. R. S.,

1. (*a*) will conduct a *Mathematical Seminary*, composed of the instructors and more advanced students of mathematics, for the presentation and discussion of papers or oral communications. He will also be accessible at other times to those students who wish to confer with him in the prosecution of their work.
2. (*b*) will lecture twice weekly during the first half year on the *Theory of Numbers*.
3. (*c*) will lecture twice weekly during the second half year on *Determinants and Modern Algebra*.

PROFESSOR CAYLEY, LL. D., D. C. L., F. R. S.,

4. will lecture twice weekly, after January 1st, on *Analytical Geometry and the Abelian and Theta Functions*.

He will also take part in the Mathematical Seminary and will guide the personal inquiries of advanced students.

W. E. STORY, A. M., Ph. D.,

5. (*a*) thrice weekly through the year on *Quaternions*.
6. (*b*) thrice weekly, first half year, on *Advanced Topics of Higher Plane Curves*.
7. (*c*) thrice weekly, second half year, on *Advanced Topics of Solid Geometry*.
8. (*d*) thrice weekly, first half year, on *Conic Sections*.
9. (*e*) thrice weekly, second half year, on *Higher Plane Curves* [*Elementary Course.*]

THOMAS CRAIG, Ph. D., of the U. S. Coast and Geodetic Survey,

10. (*a*) thrice weekly, first half year, on *Elliptic Functions and Introduction to General Theory of Functions*.
11. (*b*) thrice weekly, second half year, on *General Theory of Functions*.
12. (*c*) twice weekly, first half year, on *Spherical Harmonics*.
13. (*d*) thrice weekly, second half year, on *Partial Differential Equations*.
14. (*e*) twice weekly, first half year, on *Calculus of Variations*.
15. (*f*) thrice weekly, first half year, on *Mechanics of Rigid Bodies*.
16. (*g*) thrice weekly, second half year, on *Elasticity and Hydrodynamics*.

F. FRANKLIN, Ph. D.,

17. (*a*) thrice weekly, second half year, on *Calculus of Finite Differences*.
18. (*b*) twice weekly, second half year, on *Spherical Trigonometry*.
19. (*c*) thrice weekly, first half year, on *Solid Analytic Geometry* [*Elementary Course.*]
20. (*d*) thrice weekly, through the year, on *Differential and Integral Calculus*.
21. (*e*) thrice weekly, first half year, on *Total Differential Equations*.

PROFESSOR ROWLAND, Ph. D.,

22. (*a*) will direct the *Physical Laboratory* which is well equipped with instruments, particularly with such as are adapted to researches in Heat, Electricity and Magnetism. The Laboratory is open daily from 9 A. M. to 5 P. M.
23. (*b*) will lecture on *Thermodynamics*, on the *Theory of Heat Conduction*, and possibly on *Sound*.

C. S. HASTINGS, Ph. D.,

24. (*a*) will give a course of lectures, recitations and practical exercises, daily through the year, in *Elementary Physics*.
25. (*b*) will lecture weekly to, and will guide the laboratory work of, those who wish to pursue a more advanced course in *General Physics*.

C. S. PEIRCE, A. M., of the U. S. Coast and Geodetic Survey, will give two courses on *Logic*.

26. (*a*) a course upon the *Methods of Science*, including the methods of Mathematics.
27. (*b*) an elementary course on *General Logic*, including probabilities..
28. (*c*) He will also give a series of *Readings in Logic*.

A fuller statement of the courses in Logic is given on page 160.

October 1, 1881.

COURSES IN HISTORY, INTERNATIONAL AND CONSTITUTIONAL LAW, AND POLITICAL ECONOMY, 1881–82.

H. B. Adams, Ph. D.,

(*a*) will meet advanced and graduate students in the following courses:

First Half-year.

(1) *Sources of Early European History*, on Saturday, at 12 M.

(2) *Institutional History*, with special reference to the origin of Local Self Government in the United States, on Wednesday, at 12 M.

These classes will meet in the small lecture-room at the Peabody Institute, for facility of reference to the library collections.

Second Half-year.

(3) *Italian History*, with a special course of lectures upon the Renaissance, twice weekly.

(4) *Comparative Constitutional History*, with lectures and essays, twice weekly.

(*b*) will also give a short course of public lectures upon the *Development of Internationalism*, beginning in February.

(*c*) will conduct the minor course in History for undergraduates, five hours a week: first half-year, *Mediaeval History;* second half-year, *Diplomatic History*, including the principles of *International Law* as embodied in Bluntschli's *Völkerrecht.*

Candidates for the minor course in History must pass a preliminary examination in Freeman's "General Sketch" and Doyle's "United States," or in equivalent text-books. A knowledge of Latin, French and German is also desirable, and for the study of International Law is indispensable.

E. A. Freeman, Esq., D. C. L., of England, author of the History of the Norman Conquest, Historical Geography of Europe and other well known works, has accepted an invitation from the Peabody Institute to deliver a course of public lectures on Old, Middle, and New England, in November.

He has also accepted an invitation from the Johns Hopkins University to meet during his stay in Baltimore the historical students of the University. A more particular announcement will be made after his arrival in this country. (See p. 169.)

James Bryce, Esq., D. C. L., M. P., of London, Regius Professor of Civil Law in the University of Oxford, and author of the "Holy Roman Empire," will visit Baltimore in the autumn, and will meet the historical students at such times and places as may be appointed, for lectures on topics to which he has given special attention. (See p. 169.)

R. M. Venable, Esq., Professor in the Law Department of the University of Maryland, will give twelve public lectures on *Constitutional Law*, beginning early in January. (See p. 167.)

This course of lectures will have especial reference to the Constitution of the United States. The following subjects will be embraced in it: Constitutional law defined and its relation to the general body of the law explained; the rise and development of constitutional law, especially in England; the governments of the thirteen colonies; government during the Revolution; the Confederation; the Convention of 1787; the organization of the several departments of the Federal Government; its powers and the limitations and restrictions on them; and the limitations and re[illegible]tions on the State Governments. The provisions of the Constitution will not be discussed in the order in which they occur, but those relating to the same subject will be treated together under general heads; such as, commerce, taxation, war powers, civil and political rights, election of the President, powers of the President, Federal Courts, &c., &c. In treating each subject a brief sketch will be given of the political and legislative discussion which it has excited; and the Acts of Congress and judicial decisions bearing on the subject will be outlined and explained. While it is the prime object of the course to show the present state of our Federal Constitutional law, other matters of interest will receive such attention as the number of lectures will permit. Amongst these may be named: the theory of the partition of powers between the state governments and the general government; the question of ultimate sovereignty in cases of conflict; a comparison of the British Constitution as it now is with that of the United States; the light which the life of the nation under the Constitution throws on the question of the wisdom of its provisions, &c., &c.

A syllabus of the lectures will be issued to those attending.

Austin Scott, Ph. D., of Washington, will give a course of public lectures on the *Development of the American Constitution*, beginning early in January. (See p. 167.)

Simon Newcomb, LL. D., of Washington, will give a short course of lectures upon *Political Economy*, with special reference to the subject of *Taxation.*

Hon. John J. Knox, of Washington, Comptroller of the Currency, will give three lectures upon *Finance*, with especial consideration of the *National System of Banking*, November 10–17.

Richard T. Ely, Ph. D., will give a course of twenty class lectures on the *History of Political Economy*, beginning Friday, October 14, at 4 P. M., and continuing on successive Tuesdays and Fridays at the same hour.

The lectures will be given in Room 1, 198 North Eutaw Street.

It is designed in this course of lectures to describe the teachings of leading political economists from the time of the mercantilists up to the present. The origin of the various economic schools and their relations will be explained. The sources of economic knowledge and the methods of work will be pointed out, and topics for original investigation suggested. The writing of essays on assigned topics will be expected from the advanced students in the class.

Order of Topics.

Introductory. Utility of the Historical Method. Discussion of the Questions: What is Political Economy? What has it accomplished?

Mercantilists. Commerce. Balance of Trade.

Physiocrats. Agriculture the Sole Source of Wealth.

Adam Smith. Recognition of Manufacturing Industry as also a Source of Wealth; hence the name Industrial System.

Adam Smith's Followers: *A.* The Development of Pessimistic Tendencies, (*a*) Malthus, (*b*) Ricardo, (*c*) Mill; *B.* The Optimists, (*a*) Bastiat, (*b*) Carey.

The Opponents of Adam Smith. National Economy. Ad. Muller. Fr. List. Carey and others.

Communism.

Socialism. *A.* Social Democracy. *B.* Professorial Socialism.

The Present Condition of Political Economy; (*a*) in France, (*b*) in Germany, (*c*) in England, (*d*) in America and elsewhere.

Review of the Field and Conclusion.

P. B. Marcou, A. M., will conduct a special historical course, two hours weekly during the first half-year, in the *Modern French Socialists.*

A knowledge of French is requisite for those pursuing this course.

October 6, 1881.

PROCEEDINGS OF UNIVERSITY SOCIETIES.

Abstracts of the More Important Papers Read at Recent Meetings.

ific Association.

Meeting.

e Equilibrium Function of the Membranous Labyrinth aginous Fishes, by Henry Sewall.

veral reasons it was thought probable that research upon the
ous fish might throw new light on the relation, if such exist,
he auditory apparatus and the preservation of equilibrium.
ults of experiments made upon specimens of young sharks and
the Marine Laboratory at Beaufort may be briefly summarized
:
ion of the semicircular canals gives only negative results; no
ce of equilibrium.
ion of the ampullary nerves produces no disturbance of equili-

ion, or extirpation, or crushing of the ampullae is not necessarily
by a disturbance of equilibrium.
eration of the posterior vestibular sac, the *Utricle*, is not neces-
owed by a disturbance of equilibrium.
eration of the anterior vestibular sac, the *Sacculus*, is always
with more or less readiness by marked disturbances of equili-
hich the animal manifests by continually turning somersaults,
ing through the water in a spiral path. The experiments seem
e that only to the *Sacculus* of the membranous labyrinth can a
le equilibrium function be attributed.
esired to test experimentally recent observations of Baginsky,
rs all the peculiar results obtained by operating on the semi-
canals to mechanical stimulation of the brain, before giving a
nt of results that lead to conclusions so much at variance with
opinions.

Account of Professor Langley's Recent Expedition to itney, by W. C. Day.

per contains:
atement of the objects of the expedition, viz: a determination of
constant by means of the following instruments: Violle's Acti-
Pouillet's Pyrheliometer, and Professor Langley's Bolometer
balance. The secondary object was an attempt to see the solar
means hitherto untried, viz: by means of a tube four hundred
ngth blackened on the inside, the function of the tube being to
ffused light. An image of the sun was thrown into the tube by
inch optically plane mirror mounted on and controlled by a
A telescope placed at the further end of the tube was used
he image.
escription of the Bolometer was given and the principle of its
plained. The delicacy of the instrument was referred to, it
only one known capable of measuring the heat of different and
l wave lengths of the *grating* spectrum, as hitherto the Thermo-
l measure the heat of the solar spectrum only by concentrating
upper or lower half upon it at once. No results of measure-
re given, as they had not at the time been computed.
mainder of the paper was taken up in a description of climate,
ings, and incidents of the trip.

ninary Note upon the Theory of the Red-Lead Secondary by C. H. Koyl.

blished and generally accepted theory of the action of the new
tor is that the stored energy exists in the form of a chemical
ding to change the peroxide of lead and spongy lead, respectively,
two plates, back into minium; but that such is not the case,
may easily see by substituting a glass jar for the porcelain one
g the transformations. Further, if two plates are mechanically
ne with peroxide, the other with spongy lead, and are immersed
ated water, they should (upon this theory), either give a current
tely or should be incapable of further storing. They do not give
, but form an excellent accumulator. Upon discharge a slight
on one plate and corresponding deoxidation upon the other
ce, but this seems to be merely an accompaniment and not the
the secondary current. Exactly in what the storing consists the
opes to announce soon. He believes it to be in the mechanical
f oxygen in one coating and of hydrogen in the other. His at-
as first drawn to the point by Mr. Maloney, of Washington, who
ced that the plates when once polarized did not regain their
olor.

Philological Association.

October Meeting.

On πρίν in the Attic Orators, by B. L. Gildersleeve.

In the introduction to this paper the author made some strictures on the usual treatment of πρίν in text-books of Greek grammar and emphasized the neglect of the negative character of the particle. After discussing briefly some of the theories as to origin and use of πρίν, the writer presented the results of an investigation into the occurrences of the particle in the Attic orators, the material of which was furnished by the members of the Greek Seminary. The conclusion reached shows a certain crystallization in the use. We are far from the Homeric freedom, much nearer the scenic norm. Of individual peculiarities in the handling there is not much to be said. Isokrates treats *πρότερον-πρίν* as he treats everything else in the interest of his æsthetic seesaw and fastidious rhythm. There is more masculinity and familiarity in the abrupt use of it which characterizes Lysias for instance; but we must be careful not to refine overmuch.

A Short Review of the old French Dialects Question, particularly for France, by A. M. Elliott.

The work of the old school of dialect investigators in France was characterized, showing that their starting-point was rather that of the morphology of language than of its phonetics, and that herein they are clearly distinguished from both the German and the present French school, whose main force is concentrated on a critical study of the phonetic phenomena of each individual idiom. As an outgrowth of this favorable turn in dialect research, the report of the late Scientific Commission in France, appointed to settle more definitely the geographical boundaries of the *Langue d'oïl* and *Langue d'oc*, was referred to, and it was shown that so far as the work has gone forward, it upsets the old, generally accepted theory of the gradual and insensible *fusion* of two neighboring dialects. If for instance we take three points on a given line perpendicular to the language limit-line, say A, B, C, D, (the limit-line being between B and C, thus $\left.\dfrac{\overset{\text{A}}{\text{B}}\ \textit{Langue d'oïl}}{\overset{\text{C}}{\text{D}}\ \textit{Langue d'oc}}\right)$ we find that A is pure *Langue d'oïl*, while B has the dialect peculiarities of A *plus* a few characteristics of the *Langue d'oc*, *i. e.* the idiom south of the boundary. The same is true of the relation of D to C for the *Langue d'oc*. But there is a point between B and C where the two idioms come into sharp contact, and we have a sudden jump from the one to the other speech-form. Illustrations were drawn from the relation of German to French, also, more pointedly, of German to Hungarian, where the same linguistic conditions are forcibly exemplified in the region of their immediate contact.

The Relation of εἰδώς: ἰδυῖα, by M. Bloomfield.

The explanation of this participle must start from the Vedic forms corresponding to it: *vidvā́n* = *ἰδώς and vidúshī = *ἰδυῖα*; and it must also be remembered that the verb *οἶδα* lost its reduplication at a period so early, that it is not admissible to bring it in as factor for explanation as Curtius, Saussure and Meyer do, who explain *εἰδώς* as containing a contraction (**FεFιδώς*) of the reduplication with the root-syllable. Moreover these scholars overlook the fact that the distribution of the two stem-forms *Fειδ-* and *Fιδ-* is made according to a plan, *Fειδ* occurring with one single exception only in the masculine (69 times), *Fιδ* only in the feminine (18 times). An explanation by Brugman is also found insufficient, and the following proposed: There occur in Homer seven participial couplets in which there is regularly a difference between the stem of the masculine and that of the feminine; they are: *πεπονθώς*: *πεπαθυῖα*; *τεθηλώς*: *τεθαλυῖα*; *μεμηκώς*: *μεμακυῖα*; *λεληκώς*: *λελακυῖα*; *σεσηρώς*: *σεσαρυῖα*; *ἀρηρώς*: *ἀραρυῖα* and *ἐοικώς* (**FεFοικώς*) to *εἰκυῖα* (**FεFικυῖα*); according to the pattern of these the masculine *εἰδώς* was differentiated from the feminine *ἰδυῖα*; *εἰδώς* containing a strong root-form abstracted from the many cases in which forms with root *ειδ* have attached themselves functionally to the Perfect-system: Sigmatic Pluperfect *Fείδεα*; Subjunctives *εἴδομεν* and *εἰδῶ*, Optative *εἰδείην*. In this way alone can the regular differentiation between masculine and feminine be accounted for.

Historical and Political Science Association.

October meeting.

The Fisher Plantation at Cape Ann, by Herbert B. Adams.

This paper is the first of a series of seven chapters upon "Salem Commons and Commoners," a monograph which is to be published in full by the Essex Institute of Salem, Massachusetts, before which society extracts were read at a field meeting, August 31, 1881. The work is based upon an independent study of the Records of Massachusetts Colony, the recently published Acts and Resolves of the Province, the Town Records of Salem, the Proprietors' Records (in manuscript), the Historical Collections of the Essex Institute, and original authorities like White, Higginson, and Wood. The object of the entire research was to investigate the economic beginnings of Massachusetts, and the results show that English enterprise, English capital, and English local institutions constituted the material basis of New England. Among the economic grounds for colonial prosperity were the fisheries and the fur trade. The land question received a practical solution in the emigration of tenant farmers to America, which was then to the English mind what South Africa and Australia are to-day. Free socage tenure, the Kentish custom of Gavelkind, the old Saxon village community, which, with other local institutions, was transmitted through the English parish, all contribute to a better understanding of Puritan independence and local democracy.

In the above paper, it was shown that the Massachusetts Colony was the direct outgrowth of the colonial enterprise of New Plymouth, the economic beginnings of which were examined last year in a series of class lectures. In January, 1624, the business agents of the Pilgrims announce from England, "we have tooke a patente for Cape Anne." This patent is preserved in the library of the Essex Institute and gave its holders "free liberty to ffish, fowle, hawke, and hunt, truck and trade," within certain prescribed limits. The allotments of land were all to be in one place, and not in straggling parcels. Commons were reserved "for publig vses—for the building of a Towne, Schools, Hospitalls," and for the maintenance of ministers and magistrates. Here lie historic germs of the leading institutions which formed the town-life of New England. They are all thoroughly English, and the ancient statutes of the realm are full of legislation regarding them. Even the Yankee disposition to truck and trade, hunt and fish, was inherited from a nation of traders and adventurers, and by them from their Germanic forefathers.

The Fisher Plantation at Cape Ann proved a failure for the Pilgrims, partly because, as Bradford says, "they made so pore a bussines of their fishing;" and partly because of the exorbitant charges by London merchants for advancing colonial goods. Bradford says, "they put 40 in ye hundred upon them, for profite and adventure, outward bound; and because of ye venture of ye paiment homeward, they would have 30 in ye hundred more, which was in all 70 per cent."! The audacity of these shop-keepers who wrote their "loving friends" about "ye glorie of God and the furtherance of our countrie-men" is, however, less amazing than the fearless enterprise of colonists who dared assume such financial burdens and actually succeeded, in a few years, in paying off a debt of £2,400. They did it, not by "fishing" as they at one time proposed when King James asked "what profits" might arise, but by an extensive fur trade with the Indians, whom they paid in wampum, the value of which the Pilgrims had learned from the Dutch traders and the art of manufacturing which, from round clams (*quahaugs*), they probably acquired from the Narragansetts. The Plymouth people concluded to abandon Cape Ann for a more profitable trading post upon the Kennebec, especially as certain agents of the so-called Dorchester Company of England had sought shelter under the Cape Ann patent and as the two parties had naturally quarrelled.

Cape Ann was the stepping-stone to Salem. The Fisher Plantation failed under the new regime as it had under the old, partly because of poor success in fishing, but more especially because, at that time, Cape Ann was not a good place for a permanent settlement. The failure of the Dorchester men has frequently been ascribed to mercenary motives, but this charge is quite as unfair as it would be to ascribe Pilgrim failure to spiritual motives. The truth is, the Dorchester agents were also "religious, and well affected persons"; their leader, Roger Conant, was "a religious, sober, and prudent gentleman," according to the Puritan testimony of Hubbard. To be sure, they all leaned towards the Church of England and their pastor, the Rev. John Lyford, was an acknowledged Episcopalian. But this only shows that colonial enterprise was not a religious monopoly. The Old Planters of Cape Ann removed to Salem for economic reasons. That place afforded "a considerable quantity of planting land" and better opportunities for pasturing cattle. The perseverance of these faithful yeomen induced the Dorchester merchants, who appear to have been very honorable in their dealings, to combine with other capitalists, chiefly of London, and to send over more men and cattle. Gradually "all engaging themselves more deeply," a regular colony was fitted out, provided, at Company expense, with three ministers, who were all at that time in the Church of England and one of whom wrote, "Farewell, dear England! Farewell, the Church of God in England!"

It is impossible to ignore the significance of English capital in thus founding Massachusetts. The Fisher Plantation and the Puritan settlement cannot be separated. The Old Planters became the "overseers & Layers out of Lotts" in the new town. They were for many years the leading spirits upon the Salem board of Selèctmen, after the dissolution of Governor Endicott's local Parliament, in which, amid seven lay and three spiritual peers, the Old Planters were represented, from the outset, by two Commoners.

Parallel between the Beginnings of Maryland and Massachusetts, by L. W. Wilhelm.

Contemporary with the Cape Ann plantation was Lord Baltimore's colony in Newfoundland, or Avalon. Both were economic experiments, outcroppings of the colonial enterprise of the period. Both were undertaken primarily for fishery, secondarily for agriculture. Both failed for the time being, but both succeeded by removal of the colony to a more favorable locality. At first, Massachusetts prospered more especially through fishing, Maryland, through planting. Both colonies were founded by English capital, furnished in the one case by an enterprising nobleman, in the other, by a stock company of English capitalists and gentlemen. The two colonies started out with the idea of toleration as a matter of public policy. In Maryland, Protestants and Catholics settled side by side, the former, however, predominating numerically from the very outset. In Massachusetts, Episcopalians and Puritans were at first sent out together, but the latter proved the stronger party. Both colonies were captured by Puritans in spite of the efforts of liberal stock owners. Lord Baltimore had no thought of founding a Catholic asylum and the Dorchester Company never dreamed of a Puritan refuge when they employed Episcopalians at Cape Ann. Lingard admits that the Catholics were not persecuted in England at this period. The contest lay between the Puritans and the High Church party, whose leading prelates seriously contemplated a reunion with Rome. Lord Baltimore favored Puritans, Churchmen, and Catholics alike. His motive was a naturally broad-minded Catholic spirit, combined with a natural desire to make his colony an economic success.

Review of recent Yorktown literature and of the Map prepared by the Coast Survey for the Yorktown Centennial, by Herbert B. Adams.

Special attention was called to the articles of John Austin Stevens in the Magazine of American History, and to Johnston's "Yorktown Campaign."

Mathematical Seminary.

October meeting.

Note on an n-fold Potential, by T. Craig.

Note on the Determination of the Number of the Even and of the Odd Integer Roots of an Equation, by G. S. Ely.

On the Residues of Symmetric Functions, by O. H. Mitchell.

If $k = a^t b^u \ldots g^x h^y \ldots q^z$, where a, b, &c. are odd prime numbers, if $s = h \ldots q$, and $\Pi_k(x - \theta_s)$ denote the product $(x - \theta'_s)(x - \theta''_s)\ldots$, where the numbers θ_s are the s-totitives of k, *i. e.* those numbers not greater than k which contain s but no prime factor of k not found in s, then

$$\Pi_k(x - \theta_s) \equiv R_{\bar{a}}(x^{a-1} - 1)^{\tau_{as}(k)} + R_{\bar{b}}(x^{b-1} - 1)^{\tau_{bs}(k)} + \ldots$$

$$+ R_{\bar{g}}(x^{g-2} - 1)^{\tau_{gs}(k)} + R_{\bar{s}}x^{\tau_s(k)} \text{ mod. } k, \text{ identically;}$$

where $\tau_{as}(k)$ is the as-totient of k, &c., and $R_{\bar{a}}$ is that one of the roots of $x^2 \equiv x$ mod. k, which contains $k : a^t$ but $\equiv 1$ mod. a^t, &c. Dispensing with the "carrier" x, the formula becomes

$$\Sigma\theta'_s\theta''_s \ldots \theta_s^{[m]} \equiv (-)^{\frac{m}{a-1}} R_{\bar{a}} C^{\tau_{as}(k)}_{\frac{m}{a-1}} + \ldots + (-)^{\frac{m}{g-1}} R_{\bar{g}} C^{\tau_{gs}(k)}_{\frac{m}{g-1}}, \text{ mod. } k,$$

where only those terms of the right hand member of the congruence are to be taken for which $\frac{m}{a-1}$, $\frac{m}{b-1}$, &c. are integers.

If $\Pi_k(x - \theta)$ denote the product $(x - 1)(x - 2)(x - 3)\ldots(x - k)$, then

$$\Pi_k(x - \theta) \equiv R_{\bar{a}}(x^a - x)^{\frac{k}{a}} + R_{\bar{b}}(x^b - x)^{\frac{k}{b}} + \ldots + R_{\bar{q}}(x^q - x)^{\frac{k}{q}}, \text{ mod. } k,$$

identically; and from the development it is seen that

$$\Sigma\theta'\theta'' \ldots \theta^{[m]} \equiv (-)^{\frac{m}{a-1}} R_{\bar{a}} C^{\frac{k}{a}}_{\frac{m}{a-1}} + \ldots + (-)^{\frac{m}{q-1}} R_{\bar{q}} C^{\frac{k}{q}}_{\frac{m}{q-1}}, \text{ mod. } k,$$

where the numbers θ here comprise all the numbers not greater than k.

If k contain a power of 2, the above formulae require certain modifications.

Note on a Class of Ordinary Differential Equations of the First Order and Degree, by F. FRANKLIN.

In Boole's treatise on Differential Equations, a considerable amount of space is devoted to an examination of the cases in which the equation $Mdx + Ndy = 0$ has for an integrating factor $\frac{1}{Mx + Ny}$ or $\frac{1}{Mx - Ny}$; and it appears that the former is an integrating factor for homogeneous equations, and the latter for equations of the form $F_1(xy)ydx + F_2(xy)xdy = 0$. By precisely the same method we may obtain the more general result that $\frac{1}{Mf(x) \pm Nf(y)}$ is an integrating factor when the equation is of the form

$$uF_1[\phi(x) \mp \phi(y)]\phi'(x)dx + uF_2[\phi(x) \mp \phi(y)]\phi'(y)dy = 0,$$

where $\phi(x) = \int \frac{dx}{f(x)}$. The two classes of equations given by Boole are particular cases of this.

It is to be remarked that in all equations of this class we may, by putting $\phi(x) \mp \phi(y) = z$, obtain an equation between z and x, or z and y, in which the variables are separated. Thus, as a particular consequence, we can transform an equation of the form $F_1(xy)ydx + F_2(xy)xdy$ into an equation in which the variables are separated, by putting $xy = z$; a fact which is not mentioned by Boole.

On the Probability of the Existence of an Error in the Result of a Certain Computation, by F. FRANKLIN.

The computation referred to was that of the numerator of the reduced form of the Generating Function for the Binary Duodecimic (*vide* Amer. Jour. of Math., Vol. IV, No. 1). The coefficients in this numerator are arranged in rows and columns according to the degrees in a and in x of the terms to which they belong; and the question of error is represented with an approximation to fairness in the following supposititious case.

The result of a computation is a rectangular array of numbers, consisting of 30 rows and 20 columns; each number contains 3 digits; the total number of digits may for simplicity be regarded as 2000. Adding the numbers in each column, the sums have to agree with a preordained result, with which the process of calculation has no connection; likewise for the rows; and both tests are satisfied. Hence if there exist 1 error, there must exist at least 4, viz: a contrary error in the same row, a contrary error in the same column, and at the fourth vertex of the rectangle determined by these three, an error identical with the first one. To estimate the probability of the existence of such a compensating quadrangle of errors, we must have some idea of the *à priori* probability of an error, based upon the computer's general correctness. Say he estimates that there is *à priori* (*i. e.* before the application of the summation tests, but after the usual precautions of revision, &c.) less than 1 chance in 1000 of any given digit being wrong. He may have arrived at this conclusion by considering how often he has to correct his figures on revision; and he might convince himself that the estimate is not too favorable by the following consideration. If there is 1 chance in 1000 that any given digit is wrong, the probability that there is no error in 1000 digits is 1 in $\left(1 - \frac{1}{1000}\right)^{-1000}$, $= e +$; accordingly the *à priori* probability of the entire result being free from error is only about 1 in e^2 or say 1 in 7. Hence, if the computer has previously made several similar computations each of which there was good reason to believe to be free from error, it is evident that his estimate is extremely moderate. We shall therefore suppose the *à priori* probability of error for each digit to be 1 in 1000.

The probability of the result containing a given quadrangle of errors is 1 in $(1000)^4$; the probability that these 4 errors should be compensating might be regarded as something like 1 in 1000 (for, the first error being given, all the others are determined, and the probability of the error of a digit being a given quantity between 9 and -9 is something like 1 in 10), but as errors are more likely to be ± 1 than anything else, we shall regard this probability as 1 in 15, which is certainly on the safe side. Then the probability that the result contains a compensating quadrangle of errors occupying a given position, and no other error, is about 1 in $7.15 . (1000)^4$, or say 1 in 100 million million. But the number of possible positions for the quadrangle is obviously $\frac{1}{4} . 2000 . 30 . 20 = 300000$. Hence the probability that the result contains 1 compensating quadrangle and no other error is 300,000 in 100 million million or about 1 in 300 million. The next larger possible number of errors is 6, consisting of two rows of 3 errors each or 3 rows of 2 errors each; and it is easily seen that the probability of this is vastly smaller than that of the preceding case. The next number would be seven, being 2 quadrangles with one common vertex which is extinguished; and it might be interesting to examine what are the possible varieties of compensating polygons. But it is plain that the probabilities for all other varieties together are insignificant in comparison with that of a compensating quadrangle; and even if these probabilities formed a geometrical progression with ratio $\frac{1}{2}$, their sum would not reach double the first term; so that we are quite safe in saying that it is 150 million to 1 that the result is entirely free from error.

PEABODY INSTITUTE LECTURES, AT 8 P. M.

The following courses of lectures have been announced by the Peabody Institute.

I. The English People in their Three Homes, by E. A. FREEMAN, Esq., D. C. L., LL. D. Six lectures.

Tuesday, November 15. Old, Middle, and New England.
Thursday, November 17. The English Name.
Friday, November 18. The First Voyage and the Second.
Tuesday, November 22. The Oldest England and the Second.
Wednesday, November 23. The English in their Second Home.
Friday, November 25. The Second Voyage and the Third Home.

II. Decorative Art, by WILLIAM HENRY GOODYEAR, Esq. Four illustrated lectures.

Tuesday, November 29. Historic Style in Modern Architecture as related to the movement in Decorative Arts.
Thursday, December 1. Decorative Art in Utensils and Furniture—illustrated by historical and modern objects.
Tuesday, December 6. Philosophy of Grotesque and Conventional Forms—illustrated by historical objects bearing on the latest modern practice.
Thursday, December 7. Conventional Art in Surface Decoration—illustrated by historical designs bearing on the latest modern practice.

III. Magnetism and Electricity, by C. S. HASTINGS, Ph. D. Three experimental lectures.

Tuesday, December 13. Magnetism; Electricity at Rest.
Thursday, December 15. Electricity in Motion.
Tuesday, December 20. Induction.

IV. The Human Brain and its Relations to Mind, by JOHN VAN BIBBER, M. D.

Thursday, December 22.

V. The Great Statesmen of the Present Time, by G. M. TOWLE, Esq. Four lectures.

Tuesday, January 10. Bismarck.
Thursday, January 12. Gambetta.
Tuesday, January 17. Gladstone.
Thursday, January 19. Beaconsfield.

VI. Gothic Architecture, by Professor D. CADY EATON. Four illustrated lectures.

These lectures will treat of English ecclesiastical architecture from the Norman Conquest to the sixteenth century.

Tuesday, January 24. Norman Architecture, 1066—1189. Illustrated chiefly from Durham Cathedral.
Thursday, January 26. Early English Architecture, 1189—1307. Illustrated from Lincoln, Salisbury, and other cathedrals.
Tuesday, January 31. Decorated Architecture, 1307—1399. Illustrated from Ely, Exeter, and other cathedrals.
Thursday, February 2. Perpendicular Architecture, 1399—1547. Illustrated from Gloucester and York cathedrals, and Henry VII's chapel.

VII. The Pamphleteers, Satirists, and Song-Writers of the Revolution, by Professor M. C. TYLER. Four lectures.

Tuesday, February 7. The Whig-Writers from 1765 to 1775.
Thursday, February 9. The Tory Side of the Revolution as represented in Literature.
Tuesday, February 14. A Famous Whig Satirist:—Francis Hopkinson.
Thursday, February 16. Another Famous Whig Satirist:—Philip Freneau.

VIII. The History of the Growth of the Art of Music, by Professor W. F. APTHORP. Four lectures.

Tuesday, February 21. From St. Ambrose to the second Flemish School.
Thursday, February 23. From the Venetian School to the Music-reform of the Seventeenth Century.
Tuesday, February 28. From Carissimi to Beethoven.
Thursday, March 2. The Opera from Caccini and Peri to Wagner.

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

Published here.

American Journal of Philology. Edited by Professor Gildersleeve. *Vol. II. No.* 6. 1881.

Article I.—The New Revision of King James' Revision of the New Testament. By Charles Short.

This article is the beginning of a short series in which Professor Short expects to present in detail his critical studies in the Gospel according to St. Matthew. In the present number, he has given by way of preliminary essay 'some account of the previous English versions and of the state and treatment of the Greek text.' His review of the English New Testament embraces the versions of Wickliffe, Tyndale, Coverdale, the Genevan translation, the translations contained in the Bishop's Bible and the Douai Bible, concluding with King James' Revision. The Complutensian Bible, Erasmus' New Testament, Stephens' and Beza's editions are mentioned and characterized in the proper connection. Professor Short then takes up the work done for the Greek text since 1811, and presents a succinct account of Walton's Polyglot, of Mill's Greek Testament, and of the critical labors of Bentley, Bengel, Wetstein, Griesbach, Scholz, Lachmann, Tischendorf, and Tregelles.

Article II.—On the Consonant Declension in Old Norse, (Second and last paper). By S. Primer.

In this paper Dr. Primer has completed the study begun in the fourth number of Vol. I. The discussion of the *u*- and *i*- (*a*- and *n*-) stems is brought to a close and the remaining groups are considered under the heads of the names of relationship, the present participles and the *t* stems. The results of Dr. Primer's investigation may be summed up thus: (1) the consonant stems are still retained (at least partly) in the names of relationship, in some forms of the *-nd*, and with less certainty in some *tar*- stems. (2) The Teutonic bifurcation of the *i*-stems resulted in forming two distinct classes of words in Old Norse, Old English, and Old Frise. The loss of the characteristic vowel widened the breach and created such a divergency that these two classes were no longer to be recognized as belonging to the same original declension.

Article III.—Tóukvædhi, an Icelandic Poem from about 1650 *A. D.* Edited by William H. Carpenter.

This poem—"A Fable of the Fox"—is transcribed from a series of manuscripts in Reykjavik. The authorship of it is attributed to Hallgrímur Pètursson. Dr. Carpenter has prefixed to the text an exhibit of vowel and consonant changes and has added a few foot-notes.

Article IV.—The Negative Particle MIE *in Old French.* By B. F. O'Connor.

Mr. O'Connor has followed the development of the use of *mie* as a complementary negative from its first appearance in the XI century down to its disappearance from general use about the close of the XV century and has prepared a statistic of the occurrences of *mie* in *La Chanson de Roland*, Villehardouin's *Conquête de Constantinople* and *La Farce de Maître Pathelin.*

In the *Notes* Professor Samuel Garner defends his view of *je ne sache pas* against the attacks of Mr. Lodeman, (Vol. I, No. 4 of this Journal); Mr. A. D. Savage publishes an inscription concerning Golgoi, and Professor H. E. Shepherd makes a contribution to the history of the position of the rhematic *to* in English.

The *Reviews* and *Book Notices* contain articles on *Recent Work in Assyriology*, Körting and Koschwitz's *Französische Studien*, Suchier's *Aucassin u. Nicolete*, C. F. Smith's *Study of Plutarch's Life of Artaxerxes*, Hannsen's *De Arte Metrica Commodiani*, Ingenbleek's *Ueber den Einfluss des Reimes auf die Sprache Otfrids.*

Reports are given of *Mnemosyne*, *Hermes*, *Mittheilungen des deutschen archäologischen Instituts in Athen*, *Romania*, Fleckeisen's *Jahrbücher.*

Vol. II. No. 7. 1881.

Article I.—On the Origin of HAD RATHER GO *and Analogous or apparently Analogous Locutions.* By Fitzedward Hall.

Dr. Fitzedward Hall begins his paper with the examination of the various theories concerning "had rather," which Dr. Johnson thought to be "a barbarous expression, of late intrusion into our language," and which Lowth supposed to have arisen from confusing an abbreviation of *would* with an abbreviation of *had*. The "late intrusion" was at least [illegible] centuries old in the time of Johnson, and Lowth's hypothesis, which has been widely accepted, is false. Besides *rather* we find *better*, *best*, *need*, *as good*, *as lief*, *liefer*, (*lief* and *liefer* with a great variety of spelling.) At first the construction of *lever* was with the dative, as in: *Him was lever have* . . . Twenty bookes (Chaucer). *To have lever* with the infinitive came up in the first half of the XIV century. *Had* is a nominal verb in the sense of "*deem*," "*hold*," "*consider*," and the infinitive with or without the rhematic sign *to* is used as a verbal noun, parallel with *-ing*. The "*had*" in *had liefer*, according to Dr. Hall, "was rarely a simple preterite. Primarily it implied, in this phrase, a condition, and then, dropping the implication of conditionality, became a sort of gnomic or adagial aorist." *Had as lief* is also of venerable antiquity. A curious catachresis occurs in the combination of *had lever* with the dative, *e. g. him hadde* wel *lever* (Chaucer). Dr. Hall now traces the history of *rathe*, *rather*, *rathest* as adjectives and abverbs, *rather* as an adverb being first equivalent to *sooner* and then in turn to *preferently* and *preferably*. *Had rather* in "we had rather go than stay" was with those who originally used the expression simply substituted for *had liefer* as consciously an exact synonym of it. In like manner an "*us were better* go" sprang up analogous to "*us were liefer* go." Then came "*we were better* go," and then "*we had better* go" So "*us were as good* go" was succeeded by "*we were as good* go," which has found a conventional substitute in "*had as well* go." "Had like to have gone" is a mere monstrosity, and the anomaly which it typifies has been eschewed by the best writers of our century. As *need* may often forego the sign *to* with the infinitive, it is not singular that the nominal verb *had need* should frequently dispense with the sign. All that, over and above this, is peculiar about *had need* consists in its *had*, the vagueness of which in marking time is observable.

Article II.—The Vendidâd as translated by M. Darmesteter. By Jules Luquiens.

The conclusions which Professor Luquiens, after detailed strictures, reaches as to the merits of M. Darmesteter's translation are these: "This work is a bright and spirited rendering of a book which was not held to be either and bids fair to win for it and also for Iranian studies the attention of the reading public. If the chief aim of the translator was to bring out in the strongest light the best sense to be elicited from tradition he has been eminently successful; the outcome, however, seems to be an honor paid to the native commentators rather than the simple and direct interpretation of the Vendidâd, which we had a right to expect." While Professor Luquiens acknowledges the frankness and skill with which M. Darmesteter has avowed and championed his views as to the naturalistic method of interpretation, he thinks that "taking them out of the Introduction and weaving them through the rendering is an unwarranted way of gaining for them an adhesion and a tribute which otherwise had been denied."

Article III.—Notes on Placidus. By Henry Nettleship.

Brief corrections in the lexicographical traditions of Latin.

Article IV.—What is Articulation? By W. D. Whitney.

In this paper Professor Whitney has discussed the terms *articulate*, *articulation*, *inarticulate* and their relatives. Authorities are by no means agreed with regard to the definition. Heyse's definition, as given in his lectures, is unsatisfactory; even less satisfactory is the statement in his *System der Sprachwissenschaft.* According to Sievers and Techmer to put any organ or any complex in position for producing a sound is to articulate; and as no sound can be produced without such putting in position, every sound made by organs of utterance is an articulate sound. All this seems to Professor Whitney a misuse of a term having a real and valuable significance of its own. Articulation consists not in the mode of production of individual sounds, but in the mode of their combination for the purposes of speech. The term articulate (jointed) "is precisely and in the highest sense descriptive of human speech-utterance, as distinguished from other utterances and from the sounds produced by the organs of the lower animals," and "is one of the happiest hits ever made in the way of nomenclature by the ancient founders of our civilization and science."

Mr. Thomas Davidson, in the *Notes*, emends several passages of Sophocles, gives his interpretation of Pausanias' description of the throne of Olympian Zeus, and criticises Rawlinson's translation of Herodotus, 8, 64.

There are two elaborate *Reviews*, one of Lumsden's *Beowulf* by Professor Garnett, and one of Lepsius' *Nubische Grammatik* by Professor Whitney and a brief *Notice* of Sterrett's *Homeric Hymns.*

Reports are made of the *Journal Asiatique*, *Zeitschrift der deutschen morgenländischen Gesellschaft*, *Anglia*, *Mnemosyne*, *Germania*, *Archiv für Litteraturgeschichte*, *Archiv für mittel- u. neugriechische Philologie*, *Revue de Philologie.*

American Chemical Journal. Edited by Professor Remsen. Contents of *Vol. III, No. 4.* October, 1881.

On Osmyl-Ditetramin. By Wolcott Gibbs.

Note on the Composition of the Carbonaceous Residue from the Solution of Steel in the Double Chloride of Copper and Ammonium. By Andrew A. Blair.

Researches on the Substituted Benzyl Compounds—Parabrombenzyl Compounds. By C. Loring Jackson and Woodbury Lowery.—*The Relative Chemical Activity of Certain Substituted Benzyl Bromides.* By C. Loring Jackson.

An Abstract of the Results Obtained in a Recalculation of the Atomic Weights. By F. W. Clarke.

Method for Accurate and Rapid Analyses of Air. By E. W. Morley.

Notice of a Phosphorus-oxyiodide. By Beverly S. Burton.

Reviews and Reports: *Artificial Indigo; The Chemists at Cincinnati*, by F. W. Clarke; *Tucker's Manual of Sugar Analysis*, by C. Fahlberg.

Notes.—Recent Publications Relating to Chemistry.

American Journal of Mathematics. Editor in Chief, Professor Sylvester. Contents of *Vol. IV, No.* 1.

On the 34 Concomitants of the Ternary Cubic. By Arthur Cayley.

On Certain Expansion Theorems. By Emory McClintock.

Some Theorems in Numbers. By O. H. Mitchell.

Note on the Frequency of Use of the Different Digits in Natural Numbers. By Simon Newcomb.

Tables of the Generating Functions and Groundforms of the Binary Duodecimic, with some General Remarks, and Tables of the Irreducible Syzygies of Certain Quantics. By J. J. Sylvester.

A Demonstration of the Impossibility of the Binary Quantic of the 8th order possessing any Irreducible Covariant of the deg-order 10.4. By J. J. Sylvester.

On the Logic of Number. By C. S. Peirce.

Notes. By Emory McClintock, Miss Christine Ladd, and Thomas Muir.

Studies from the Biological Laboratory. Edited by Professor Martin. Associate Editor, Dr. W. K. Brooks. Contents of *Vol. II, No.* 2. (In press.)

(The following articles not hitherto published.)

The Medusæ of Beaufort, N. C. By W. K. Brooks, Ph. D.

The Development of Test-cells in Ascidians. By J. Playfair McMurrich. With one plate.

A Contribution to the Study of the Bacterial Organisms commonly found upon Exposed Mucous Surfaces and in the Alimentary Canal of Healthy Persons. By Geo. M. Sternberg, M. D., Surgeon, U. S. A. With three plates.

The Development of the Ova in Salpa. By W. K. Brooks, Ph. D. With one plate.

A Preliminary Account of Experiments relating to the Influence of Variations of Arterial and Venous Pressure upon the Rate of the Heart Beat in Mammals. By H. Newell Martin, M. A., D. Sc., M. D.

Notes on the Development of Arbacia. By B. P. Colton, B. Sc., and H. Garman.

(Also reprints of the following articles based on researches carried on in the Biological Laboratory and Marine Station of the University, and already elsewhere published.)

A Fatal Form of Septicæmia in the Rabbit, produced by the Subcutaneous Injection of Human Saliva. By Geo. M. Sternberg, M. D. With one plate.

Experiments on Disinfectants. By Geo. M. Sternberg, M. D.

On the Development of Starch Grains. By A. F. W. Schimper, Ph. D.

Studies on the Mean Arterial Pressure in the Coronary Arteries of the Heart. By H. Newell Martin, M. A., D. Sc., M. D., and W. T. Sedgwick, Ph. D. With plates.

On the Structure and Significance of some Aberrant Forms of Lamellibranchiate Gills. By K. Mitsukuri, Ph. B. With one colored plate.

The Origin and Significance of the Metamorphosis of Actinotrocha. By Edmund B. Wilson, Ph. D. With two plates.

The Effect upon Nerves of very weak Induction Currents. By Henry Sewall, Ph. D.

HOPKINS HALL LECTURES, AT 5 P. M.

The following lectures to be given in Hopkins Hall, during the months of January–March, 1882, will be open to the public, subject to the regulations as to tickets, etc., heretofore announced.

I. Austin Scott, Ph. D., of Washington. Ten lectures on *The Development of the American Constitution*, beginning Wednesday, January 4, and continuing on successive *Mondays* and *Wednesdays* to February 6.

II. R. M. Venable, Esq., Professor in the Law Department of the University of Maryland. Twelve lectures on *Constitutional Law*, beginning Thursday, January 5, and continuing on successive *Thursdays* to March 23. (See p. 162.)

III. Professor G. Stanley Hall, Ph. D., Lecturer in Harvard and Williams Colleges. Ten lectures on *Psychology*, beginning Friday, January 6, and continuing on successive *Tuesdays, Fridays*, and *Saturdays* to January 27. (See p. 160.)

IV. Professor W. W. Goodwin, Ph.D., of Harvard University. Three lectures on the *Republic of Plato*, beginning early in February.

SPECIAL NOTICES AND CURRENT INTELLIGENCE.

THE DEATH OF PRESIDENT GARFIELD.

At an Assembly of the Officers and Students of the University in Hopkins Hall on Tuesday, September 27, the opening of the current academic year, the following minute was presented by the Hon. George W. Dobbin, President of the Board of Trustees, and having been seconded by Professor Ira Remsen, was unanimously adopted by a rising vote:

> Before entering upon the business for which we are assembled it is meet that we should advert to the great sorrow which afflicts the nation in its deepest sensibility.
>
> The mournful feelings of yesterday, when the late President was laid in his grave and all heads were bowed in sorrow, still linger with us, and it is yet too soon to enter upon the usual business of life in forgetfulness of the sad event which has steeped this nation in grief, and has called forth the sympathetic sorrow of the whole world. When, so soon after a political strife in which partizan zeal worked with unbridled license, a nation is stunned with horror and the rancor of party stricken from existence and in its place is substituted the justice which is eager to acknowledge, without dissent, personal worth, heroic bravery, and unselfish patriotism, we realize the saying of a distinguished writer that a virtuous people may err in their opinions, but in their sentiments they never do. In all the relations he bore to this life, Garfield the son, the husband, the father,—the citizen realizing in the example of his career, in its rise and progress to success, the best instance of the value of our democratic institutions,—the unseeking, scholarly statesman, elevated, with no effort of his own to the highest office in the gift of his countrymen,—the patient sufferer and heroic martyr, shines conspicuous, and his untimely death has banished sectional distrust and party dissent, and woven into one unvarying fabric the warp and woof of this wide spread nation.
>
> But our sense of loss needs not the stimulant of eulogy, for the whole nation has given the strongest utterance to its grief, and all civilization has re-echoed the wail of sorrow.
>
> I feel, then, that I am only giving voice to the wish of all here present, when I ask, in the name of the Trustees, the Professors, the Fellows, and the Students of the Johns Hopkins University, that record may be made of our profound sorrow at the death of President Garfield, whose previous life and short official career had given promise of an administration of purity, usefulness, and unselfish patriotism, and in whose death the cause of education has lost a most helpful friend.
>
> We further add our sincerest condolence to that which has come from all the world beside, to his bereaved family.

THE DEATH OF SIDNEY LANIER.

Sidney Lanier, Lecturer on English Literature in the Johns Hopkins University, died at Lynn, North Carolina, September 7, 1881, in the fortieth year of his age.

The University was not in session at the time of his death, but, on October 22, a meeting was held in Hopkins Hall, of his colleagues, pupils, and other friends, to commemorate his life and character.

A pamphlet containing a full report of the proceedings of the meeting has been printed and may be obtained on application.

From the biographical sketch read at the meeting, by Dr. William Hand Browne, the following data are extracted.

> Sidney Lanier, the eldest son of Robert and Mary Lanier, was born in Macon, Georgia, on February 3, 1842. He was educated at Oglethorpe College in the same State, where he took his degree with the highest honors.
>
> At the outbreak of the war of 1861 he enlisted in the Georgia Battalion, afterwards incorporated into the Army of Northern Virginia. After serving about a year in the infantry, he was transferred to the mounted signal corps. In 1864, while serving as signal-officer on board the steamer *Annie*, he was captured by a Federal blockader, and sent as a prisoner to Fort Lookout, where he remained until the close of the war.
>
> After the return of peace, he studied the law, and became a partner, with his father and uncle, in the firm of Lanier and Anderson, at Macon. In 1867 he married Miss Mary Day, of Macon.
>
> His health, which had been seriously impaired by his imprisonment, soon showed signs of breaking down; and he was compelled to abandon the legal profession. He then turned to literature, for which he had always had a strong predilection, and thought of making New York his home. While on his way thither, in September, 1873, his performance on the flute, at a friend's house in Baltimore, was heard by Mr. Asger Hamerik, who at once offered him a position in the Peabody Orchestra, which he retained for several years.
>
> During his residence in Baltimore, he published various poems in the periodicals of the day, one of which, entitled "Corn," attracted much attention. In 1876 he was engaged to write the cantata for the opening of the Centennial Exhibition in Philadelphia; and soon after this a selection of his poems was published in book-form.
>
> In the winter of 1879–80 he delivered a course of public lectures in the Johns Hopkins University on "English verse, especially Shakespeare's," which was followed by the publication of his *Science of English Verse*.
>
> To this succeeded his *Boy's Froissart*, and *Boy's King Arthur*, two books intended to familiarize the minds of the young with the best aspects of ancient chivalry and legend.
>
> In the winter of 1880–81, though his health had been steadily declining, he again lectured in the University on English Literature, giving especial attention to the novelists and romancers. In the spring his malady had made such progress, that he was advised to try, as a last resort, open-air life in a milder climate, for which purpose he went to the highland near Asheville, North Carolina. The experiment, unhappily, proved unavailing, and he died, on the 7th of September, at the village of Lynn.

REGULATIONS AS TO GRADUATE SCHOLARSHIPS.

Six honorary scholarships yielding two hundred and fifty dollars each, in addition to tuition, are open to graduates of this or of other institutions now studying here.

They will be awarded in accordance with the following regulations:

1. Regard shall be paid to exceptional merit in the prosecution of study and not to the pecuniary circumstances of the candidates.
2. Applications may be filed as late as December 15, but the selection will not necessarily be made from the list of formal applicants.
3. Holders of scholarships must devote their whole time to study in this University and not engage in teaching.

NOTE IN RESPECT TO COURSES IN FRENCH AND GERMAN.

If a student have matriculated with the aid of the minor course of either French or German, and take this language as one of his major studies, since this major course may be completed by the work of one year, whereas major courses in general require the work of at least two years, he shall, at the discretion of his adviser, pursue either one of his minor subjects through an additional year, or an additional minor subject.

BRIEF ANNOUNCEMENTS.

Hon. John J. Knox, Comptroller of the Currency, U. S. Treasury Department, gave three lectures, on *The Banking Systems of the United States*, in Hopkins Hall, November 10–17.

E. A. Freeman, Esq., D. C. L., LL. D., during the progress of his public course at the Peabody Institute, gave six lectures in Hopkins Hall to the University students on the *Historical Geography of Southeastern Europe.* The special subjects considered were: The Roman Power in the East; The Saracens and the Slaves; The Final Division of East and West; The Turks, Franks, and Venetians; The Ottomans; The Beginnings of Deliverance.

James Bryce, Esq., M. P., D. C. L., Regius Professor of Civil Law in the University of Oxford, gave five lectures on *Some English Problems*, to the students of History and Political Science, in Hopkins Hall, November 21–25. The special topics considered were: The Crown and the House of the Lords; The Church and the Universities; The Suffrage and the Distribution of Seats; The Land and the Poor; Foreign and Colonial Policy.

Mr. Bryce also gave a special lecture upon the Relations of Law and History.

M. Rabillon, Lecturer on French Literature, began a course of lectures (in French) on the *Satirists of France*, October 20. This course will continue on successive Wednesdays and Saturdays to December 10.

The Trustees have admitted, on the recommendation of the Academic Council, Mitsuru Kuhara, (S. B., University of Tokio, 1877; Fellow, J. H. U., 1879–81), to the degree of *Doctor of Philosophy.* He passed the required examinations in Chemistry, as a principal subject, and in Mineralogy, as a subordinate subject. He presented a thesis on the Oxidation of Nitro-meta-xylene.

The *Société d'Acclimatation* of Paris has awarded its medal of the first class to W. K. Brooks, Ph. D., Associate in Biology, for his work upon "The Development of the Oyster."

The *Reale Istituto Veneto di Scienze, Lettere ed Arti* has awarded its premium of 1500 lire, in accordance with its circular of August 14, 1879, to Professor H. A. Rowland for his essay on the Mechanical Equivalent of Heat. This essay has been translated into Italian and will be published by the Institute.

Professor Rowland, having been appointed by the U. S. Department of State a Delegate to the International Congress of Electricians at Paris, was in attendance upon the sessions of the Congress during the month of September. He has also been appointed by the French Government a member of the International Commission on Electrical Standards, in connection with the International Bureau of Weights and Measures.

It is expected that Professor Arthur Cayley will reach Baltimore before the close of December and begin his lectures at the University in the first week of January, as elsewhere announced. (See p. 161.)

Dr. Alan P. Smith and J. Hall Pleasants, Esq., have been chosen to fill the vacancies in the Board of Trustees of the Johns Hopkins University, caused by the deaths of Galloway Cheston and Wm. Hopkins.

The usual Holiday Recess will begin on Friday, December 23. Instructions will be resumed on Wednesday, January 4, at 9 A. M.

RECENT APPOINTMENTS.

B. C. Burt, (*A. B., Univ. of Mich.*, 1875; *F.*)—Assistant Professor of English and Rhetoric, University of Michigan.

W. H. Carpenter, (*Ph. D., Freiburg*, 1881.)—Fellow by Courtesy, Johns Hopkins University.

S. R. Cheek, (*A. B., Centre College, Ky.*, 1875; *Graduate Student*, 1879–81.)—Professor of Latin and English, Centre College.

S. F. Clarke, (*Ph. D.*, 1879; *F.*)—Professor of Natural History, Williams College.

S. C. Derby, (*Fellow by Courtesy*, 1879–80.)—Professor in the Ohio State University.

R. T. Ely, (*Ph. D., Heidelberg*, 1879.)—To deliver a course of lectures on Political Economy, Johns Hopkins University.

L. B. Fletcher, (*Ph. D.*, 1881; *F.*)—Assistant in Physics, University of Pennsylvania.

Samuel Garner, (*Ph. D.*, 1881.)—Professor of Modern Languages, University of Indiana.

B. I. Gilman, (*A. B., Williams*, 1872.)—Fellow in Logic, Johns Hopkins University.

J. W. Gore, (*C. E., Univ. of Va.*, 1875; *F.*)—Assistant Professor of Mathematics, University of Virginia.

E. H. Hall, (*Ph. D.*, 1880; *F.*)—Instructor in Physics, Harvard University.

Allan Marquand, (*Ph. D.*, 1880; *F.*)—Lecturer on Advanced Logic and Tutor in Latin, Princeton College.

J. H. Miller, (*A. B., Erskine College (S. C.)*, 1880; *Graduate Student*, 1881.)—Professor of Mathematics, Erskine College.

E. L. Nichols, (*Ph. D., Göttingen*, 1879; *F.*)—Professor of Physics and German, Central University, Richmond, Kentucky.

B. E. Smith, (*A. M., Amherst*, 1880.)—Instructor in Mental and Moral Philosophy, Johns Hopkins University.

C. A. Van Velzer, (*S. B., Cornell Univ.*, 1876; *F.*)—Assistant Professor of Mathematics, University of Wisconsin.

B. W. Wells, (*Ph. D., Harvard*, 1880; *F.*)—Instructor in English, Friends' School, Providence, R. I.

J. H. Wheeler, (*Ph. D., Bonn*, 1879; *F.; late Tutor in Greek, Harvard University.*)—Professor of Latin, Bowdoin College.

Henry Wood, (*Ph. D., Leipsic*, 1879; *late Instructor in Friends' School, Providence, R. I.*)—Associate in English, Johns Hopkins University.

RECENT PUBLICATIONS.

Henry C. Adams, (Ph. D., 1878; F.)—Payment of Public Debts. (*International Review, September*, 1881, *pp.* 12.)
Democracy. (*New Englander, November*, 1881, *pp.* 21.)

W. K. Brooks, (F; Associate.)—Lucifer: a Study in Morphology. (*Proc. Royal Soc., London, No.* 212, 1881, *pp.* 8.)
Alternation of Periods of Rest with Periods of Activity in the Segmenting Eggs of Vertebrates. (*Studies from the Biol. Lab., Vol. II, No.* 1, *pp.* 8, 1 *Plate.*)
The Development of the Ova in Salpa. (*Studies from the Biol. Lab., Vol. II, No.* 2, *in press.*)
The Embryology of Lucifer. (*Phil. Trans. Royal Soc., London, with* 12 *Plates, in press.*)
The Medusae of Beaufort, N. C. (*Studies from the Biol. Lab., Vol. II, No.* 2, *pp.* 14.)
—— and E. B. Wilson.—The First Zoea of Porcellana. (*Studies from the Biol. Lab., Vol. II, No.* 1, *pp.* 7, 2 *Plates.*)

P. H. Broun, see Ira Remsen.

William Hand Browne, (Librarian.) [*Translator.*]—Greece and Rome. Their Life and Art, by Jacob von Falke. (*New York*, *Holt*, 1881, *fol.*, *pp.* 852.)

S. F. Clarke, (Ph. D., 1879; F.)—The Early Development of the Wolffian Body in Amblystoma Punctatum. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 1, *pp.* 6, 8 *Plates.*)

R. D. Coale, see Ira Remsen.

B. P. Colton and **H. Garman**, (Students in Biology, 1881.)—Notes on the Development of Arbacia. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 2, *in press.*)

W. T. Councilman, (Graduate Student, 1878–80.)—A Contribution to the Study of Inflammation as illustrated by Induced Keratitis. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 1, *pp.* 12, 1 *Plate.*)

T. Craig, (Ph. D., 1878; F.; Associate.)—On Certain Possible Cases of Steady Motion in a Viscous Fluid. (*Amer. Jour. of Math.*, *Vol. III*, *Nos.* 3, 4, *pp.* 25.)

Distortion of an Elastic Sphere. (*Jour. für die reine und angewandte Mathematik*, 1881, *pp.* 14.)

On Certain Partial Differential Equations analogous to those of Hydrodynamics. (*Amer. Acad. of Science*, 1881.)

Note on Abel's Theorem. (*London Math. Soc. Proc.*, 1881, *pp.* 3.)

W. C. Day, see H. N. Morse.

F. Franklin, (Ph. D., 1880, F.; Assistant.)—Sur le Développement du Produit Infini $(1-x)(1-x^2)(1-x^3)(1-x^4)\ldots\ldots$ (*Comptes Rendus*, *XCII*, *p.* 448, *pp.* 2.)

S. Garner, (Ph. D., 1881.)—Note on *je ne sache pas.* (*Amer. Jour. of Philol.*, *Vol. II*, *No.* 6, *pp.* 6.)

D. C. Gilman, (President.)—The Idea of the University. (*North American Review*, *October*, 1881, *pp.* 15.)

E. H. Hall, (Ph. D., 1880; F.)—The "Rotational Coefficient" in Nickel and Cobalt. (*London*, *Dub. and Edinb. Phil. Mag.*, *October*, 1881, *pp.* 15.)

G. B. Halsted, (Ph. D., 1879; F.)—Mensuration: Metrical Geometry. (*Boston*, *Ginn*, *Heath & Co.*, 1881, *pp.* 232.)

E. M. Hartwell, (Ph. D., 1881; F.)—The Study of Human Anatomy Historically and Legally Considered. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 1, *pp.* 52.)

Allan Marquand, (Ph. D., 1880; F.)—On Logical Diagrams for *n*-Terms. (*London*, *Dub. and Edinb. Phil. Mag.*, *October*, 1881, *pp.* 4.)

H. N. Martin, (Professor.)—A New Method of Studying the Mammalian Heart. (*Medical and Chirurgical Faculty of Maryland*, *Transactions*, 1881, *pp.* 13, 1 *Plate*; *Studies from the Biol. Lab.*, *Vol. II*, *No.* 1.)

The Influence of Variations in Arterial Pressure upon the Rate of Beat of the Mammalian Heart. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 2, *in press.*)

—— and **W. A. Moale**, (Graduate Student.)—Handbook of Vertebrate Dissection, part I. (*New York*, *MacMillan & Co.*, 1881, *pp.* 94.)

—— and **W. T. Sedgwick**, (Ph. D., 1881; F; Associate.)—A Study of Blood Pressure in the Coronary Arteries of the Mammalian Heart. (*Medical and Chirurgical Faculty of Maryland*, *Transactions*, 1881; *Studies from the Biol. Lab.*, *Vol. II*, *No.* 2.)

J. Playfair McMurrich, (Student in Biology, 1881.)—The Development of the Test-cells in Ascidians. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 2, *in press.*)

O. H. Mitchell, (F.)—On Binomial Congruences: Comprising an Extension of Fermat's and Wilson's Theorems and a Theorem of which both are Special Cases. (*Amer. Jour. of Math*, *Vol. III*, *No.* 4, *pp.* 22.)

Some Theorems in Numbers. (*Amer. Jour. of Math.*, *Vol. IV*, *No.* 1, *pp.* 14.)

K. Mitsukuri, (F.)—On the Structure and Significance of some Aberrant Forms of Lamellibranchiate Gill. (*Quarterly Journal of Microscopical Science*, *October*, 1881, *pp.* 14; *Studies from the Biol. Lab.*, *Vol. II*, *No.* 2).

W. A. Moale, see H. Newell Martin.

C. D. Morris, (Professor.)—Report of Mnemosyne, Vol. IX, part 2. (*Amer. Jour. of Philol.*, *Vol. II*, *No.* 7, *October*, 1881.)

G. S. Morris, (Lecturer.) [*Editor.*]—German Philosophical Classics for English Readers and Students. (*Chicago*, *Griggs & Co.*, *in press.*)

H. N. Morse, (Associate,) and **W. C. Day**, (A. B., 1880; F.)—Determinations of Chromium in Chrome Iron Ore. (*Amer. Chem. Jour.*, *Vol. III*, *No.* 3, *pp.* 2.)

E. L. Nichols, (F.)—Note on the Electrical Resistance and the Coefficient of Expansion of Incandescent Platinum. (*Amer. Jour. of Science*, *November*, 1881, *pp.* 5.)

B. F. O'Connor, (F.)—Negative Particle *mie* in Old French. (*Amer. Jour. of Philol.*, *Vol. II*, *No.* 6, *pp.* 3.)

W. H. Page, (F.)—The Southern Educational Problem. (*International Review*, *October*, 1881, *pp.* 11.)

C. S. Peirce, (Lecturer.)—On the Logic of Number. (*Amer. Jour. of Math.*, *Vol. IV*, *No.* 1, *pp.* 12.)

W. S. Pratt, (F.)—The Origin and Development of Musical Scales. (*Princeton Review*, *October*, 1881, *pp.* 19.)

The Church Organist. (*New Englander*, *November*, 1881, *pp.* 13.)

Ira Remsen, (Professor.)—Chemical Action in a Magnetic Field. (*Amer. Chem. Jour.*, *Vol. III*, *No.* 3, *pp.* 7.)

Carbonic oxide as a Source of Danger to Health in Rooms Heated by Cast-iron stoves or Furnaces: Report to National Board of Health. (*National Board of Health Bulletin*, *Vol. II*, *p.* 857, *pp.* 4.)

Report on a peculiar condition of the Water of Boston in November, 1881. (*Boston City Document*, *No.* 147, *pp.* 24.)

—— and **R. D. Coale**, (Ph. D., 1881; F; Assistant.)—Oxidation of Sulphamine metatoluic Acid in Alkaline and in Acid Solution. (*Amer. Chem. Jour.*, *Vol. III*, *No.* 3, *pp.* 13.)

—— and **P. H. Broun**, (Graduate Student.)—Concerning Mesitylenic Sulphinide. (*Amer. Chem. Jour.*, *Vol. III*, *No.* 3, *pp.* 5.)

Josiah Royce, (Ph. D., 1878; F.)—"Mind-stuff" and Reality. (*Mind*, *July*, 1881, *pp.* 13.)

Pessimism and Modern Thought. (*Berkeley Quarterly*, *October*, 1881, *pp.* 25.)

A. F. W. Schimper, (F.)—Researches upon the Development of Starch Grains. (*Quarterly Journal of Microscopical Science*, *April*, 1881; *Studies from the Biol. Lab.*, *Vol. II*, *No.* 2, *in press.*)

W. T. Sedgwick, (Ph. D., 1881; F; Associate.)—The Influence of Quinine upon the Reflex Excitability of the Spinal Cord. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 1, *pp.* 16.)

—— see H. N. Martin.

H. Sewall, (Ph. D., 1879; F; Associate.)—A Note on the Processes Concerned in the Secretion of the Pepsin-forming Glands of the Frog. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 1, *pp.* 3.)

On the Polar Influences upon Nerves of very weak Induction Currents. (*Journal of Physiology*, *in press.*)

C. Sihler, (Ph. D., 1881; F.)—Some Further Observations on Heat-Dyspnœa. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 1, *pp.* 10.)

Notes on the Formation of Dentine and of Osseous Tissue. (*Studies from the Biol. Lab.*, *Vol. II*, *No.* 1, *pp.* 13, 1 *Plate.*)

E. G. Sihler, (Ph. D., 1878; F.)—Plato: Protagoras. *Edited* with an introduction and critical and explanatory notes. (*New York*, *Harper & Brothers*, 1881, *pp.* 157.)

G. M. Sternberg, (Fellow by Courtesy.)—A Fatal Form of Septicæmia in the Rabbit, produced by the Subcutaneous Injection of Human Saliva: an experimental research. (*Medical and Chirurgical Faculty of Maryland*, *Transactions*, 1881, *pp.* 10; *Studies from the Biol. Lab.*, *in press.*)

Experiments with Disinfectants. (*National Board of Health Bulletin*; *to appear in fuller form in Studies from the Biol. Lab.*)

A Contribution to the Study of the Bacterial Organisms commonly found upon Exposed Mucous Surfaces and in the Alimentary Canal. (*Studies from the Biol. Lab.*, *in press.*)

W. E. Story, (Associate.)—On the Theory of Rational Derivation on a Cubic Curve. (*Amer. Jour. of Math.*, *Vol. III*, *No.* 4, *pp.* 31.)

J. J. Sylvester, (Professor.)—A Point in the Theory of Vulgar Fractions: 2 notes. (*Amer. Jour. of Math.*, *Vol. III*, *No.* 4, *pp.* 6.)

Instantaneous Proof of a Theorem of Lagrange on the Divisors of the Form $Ax^2 + By^2 + Cz^2$. (*Amer. Jour. of Math.*, *Vol. III*, *No.* 4, *pp.* 3.)

Tables of the Generating Functions and Groundforms of the Binary Duodecimic, with some General Remarks, and Tables of the Irreducible Syzygies of Certain Quantics. (*Amer. Jour. of Math.*, *Vol. IV*, *No.* 1, *pp.* 21.)

A Demonstration of the Impossibility of the Binary Quantic of the 8th order possessing any Irreducible Covariant of the deg-order 10.4. (*Amer. Jour. of Math.*, *Vol. IV*, *No.* 1, *pp.* 23.)

E. B. Wilson, (Ph. D., 1881; F.; Assistant.)—Origin and Significance of the Metamorphosis of Actinotrocha. (*Quarterly Journal of Microscopical Science*, *April*, 1881, *pp.* 18, 2 *Plates*; *Studies from the Biol. Lab.*, *Vol. II*, *No.* 2.)

Report on the Pycnogonida. (*Bull.*, *Mus. Comp. Zoöl.*, *Cambridge*, *Vol. VIII*, *No.* 12, *pp.* 18, 5 *Plates.*)

—— see W. K. Brooks.

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CALENDAR, 1881-82.

September 20.	**Current Academic Year Began.**
February 22.	**Commemoration Day.**
April 7—10.	**Spring Recess.**
June 5—8.	**Matriculation Examinations.**
June 9.	**Term of Instruction Closes.**
September 19.	**Next Academic Year Begins.**
September 20—23.	**Matriculation Examinations.**
September 26.	**Instructions Resumed.**

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MEETINGS OF SOCIETIES.

Scientific. First Wednesday of each month, at 8 P. M. Next meeting, March 1.
S. H. Freeman, Secretary.

Philological. First Friday of each month, at 12 M. Next meeting, March 3.
M. Warren, Secretary.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, March 14.
B. I. Gilman, Secretary.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, March 17.
H. B. Adams, Secretary.

Mathematical. Third Wednesday of each month, at 8 P. M. Next meeting, March 15.
O. H. Mitchell, Secretary.

Naturalists' Field Club. Excursions each Saturday during the Spring and Autumn. Regular meetings for the reading and discussion of papers once a month.
H. F. Reid, Secretary.

PROCEEDINGS OF UNIVERSITY SOCIETIES.

Abstracts of the More Important Papers Read at Recent Meetings.

Scientific Association.

November meeting.

On the Direct Influence upon the Pulse Rate of Variations in Arterial Pressure, by H. Newell Martin.

That a raising or lowering of mean pressure in the systemic arteries influenced the rate of the heart beat has been known for some time; but, unless the nerves going to the heart from outside of it be severed, this fact proves nothing as to a direct action upon the heart of variations in aortic tension. Various experimenters have cut the extrinsic cardiac nerves, and then raised or lowered arterial pressure, and counted the pulse; any change in the latter was then assumed to be directly due to the influence of the increased or lowered pressure.

A critical examination of the methods employed however shows that such an assumption is not justified. Usually in these cases arterial pressure has been raised by compressing the aorta, and lowered by removing a previous compression. In this way not only is arterial pressure altered but (1) The amount of blood returned to the right auricle in a given time. (2) Probably the pressure under which this venous blood is returned. (3) The temperature of blood entering the heart from the inferior cava is higher than that returned by the superior cava; when the aorta is tied this warm abdominal blood is cut off from the heart, and this change of temperature may very well change its rate of beat. (4) We know that very minute quantities of various substances in the blood may profoundly alter the cardiac rhythm; and also that in circulating through the abdominal viscera the blood undergoes important chemical changes; all these are stopped when the aorta is ligated; and the blood supplied to the heart may then have in it, in greater proportion than normal, things which are removed by the abdominal viscera, or have absent from it things normally present and added by the abdominal viscera; the extra amount or the deficiency of such substances may alter the cardiac rhythm. In a reverse direction all the above disturbing elements come in when compression is removed from a previously closed aorta.

By other experimenters arterial pressure has been raised by transfusion of blood from another animal, or lowered by bleeding. Here again we find several secondary changes produced in addition to the change in arterial pressure. The quantity of blood reaching the right auricle in a given time, and the pressure of this blood in the auricle would be apt to undergo change during transfusion or bleeding. During the former, unless great care be taken, the temperature of the injected blood may differ so much from that of the animal experimented upon as, in itself, to produce a marked change in the cardiac rhythm; and, when bleeding is resorted to, the flow through all organs of the body may be so diminished as to appreciably alter the amount of various substances carried to the heart in the blood in a given time.

When such possible disturbing elements are neglected in interpreting the results of an experiment it is not surprising that different workers arrive at very different results, or even the same worker in different experiments. Tschirjew, the latest experimenter, finds that increased arterial pressure sometimes slows and sometimes quickens the pulse, and sometimes has no effect at all; results which necessitate highly complex hypotheses for their explanation.

In recent experiments made by the author, a dog's heart, isolated from the whole body except the lungs, by tying up all the systemic vessels except those of the heart itself (*see Studies from Biol. Lab., Vol. II, No.* 1, *p.* 119) was employed. Defibrinated blood of constant temperature was sent into its right auricle under steady pressure from a Marriott's flask, and arterial pressure varied by opening or closing a stop-cock placed in connection with the stump of one carotid. The pressure changes and pulse rate were recorded in the usual way by means of a mercury manometer connected with one subclavian. Under these circumstances arterial pressure alone is varied, and it is found that between 150 and 20 mm. of mercury no alteration in it has the slightest direct influence upon the rate of the heart's beat.

A Fallacy of Induction, by C. S. Peirce.

An Account of the Recent Electrical Exhibition and Congress, by H. A. Rowland.

December meeting.

Some Account of an Examination of the Boston Drinking Water, by Ira Remsen.

The examination here referred to was undertaken at the urgent request of the Boston City Council, for the purpose of ascertaining, if possible, the cause of the offensive taste and odor of the water which for some weeks had caused great annoyance to the citizens. The first examination showed at once that the water had the well known "cucumber taste" which was noticed in the water of Baltimore last winter. By means of chemical and other experiments the source of the trouble was traced to a pond at South Framingham, about twenty miles from Boston. This body of water, known as Farm Pond, receives its water indirectly from the Sudbury River, the water of which was found to be good. Having traced the difficulty to Farm Pond, the question still remained to be answered: Did the trouble originate here or in the Sudbury River? No trace of the taste or odor could be detected anywhere beyond the pond, while the whole pond was undoubtedly affected. Specimens were collected from various parts of the surface of the pond, then from various depths, and finally specimens of the bottom mud itself.

An examination of the specimens showed that the water was somewhat worse at the lower than at the upper end, and further that, in general, it became worse the deeper down the specimens were taken. From this it was suspected that the source of the difficulty is in the bottom of the pond. A careful examination of the specimens collected from the bottom showed the presence of vegetable remains; of microscopic animals; of some green gelatinous masses which were recognized as algæ, belonging to the Nostoc family; and of the spicules of silicious sponges. The Nostocs being notorious for producing bad odors, were at first suspected. On this point Prof. W. G. Farlow, of Harvard University, was consulted. He looked thoroughly into the matter and finally expressed himself as perfectly satisfied that these Nostocs are not the cause of the "cucumber taste." A body of water in which large quantities of the Nostocs were growing was visited by the speaker in company with Prof. Farlow, and this water was found to be perfectly tasteless and inodorous. There is no evidence whatever in favor of the view that the Nostocs can produce the "cucumber taste."

Visiting Farm Pond again, the speaker made a close examination of the screens through which the water passes before its entrance into the conduit. In regard to this he said: "Men were engaged in cleaning one of these screens at the time. For this purpose a portion of the screen, about two feet in length, was exposed by turning it on rollers. This was then cleaned and another portion exposed, and so on. The cleaning consisted in simply picking off the materials which could not pass through the small apertures of the screen. These were made up of dead leaves from the surface of the pond, an occasional piece of grass and some curious masses, partly green, and partly brownish. These were evidently organized. I smelt of everything found and was soon forcibly struck by the strong disagreeable odor of the organized masses just referred to. The odor was extremely disagreeable and suggestive in the highest degree of the "cucumber odor." Two gentlemen who accompanied me exclaimed without hesitation that the substance had the odor of the "cucumber water," only the odor was much intensified. I collected a considerable quantity of the substance and convinced myself that each piece picked up had this strong odor, and, further, that pieces of it were constantly being stopped by the screen. At every turn which exposed a new surface of the screen several pieces were found. Some of these were as much as four or five inches in length, though most of them not more than an inch. The other materials picked off the screen did not have any odor in the least striking. There is not the slightest doubt that this peculiar substance is the only thing thus far found in the pond which has an odor unquestionably like that of the "cucumber water," and this substance must be present in considerable quantity or it would not have been found to the extent described above.

"Now, what is this substance? Professor Farlow to whom I submitted it first pronounced it to be a fresh-water sponge. Acting on this information, I at once took my specimens to Professor Alpheus Hyatt, Curator of the Boston Society of Natural History, a recognized authority of the highest standing on the subject of sponges, as well as other subjects. He kindly examined them and pronounced them to be sponges. He, too, was struck by the odor, and recognized the strong similarity between this odor and that of the "cucumber water." His remarks on the subject are herewith submitted.

“The specimen is that known as *Spongilla fluviatilis Auct.* (According to a letter from Prof. H written at a later date, the specimen is really *Spongilla lacustris*). This sponge is common in all fresh-water ponds and in certain places is very abundant. While living it has a very strong odor, which is increased by decomposition. Masses of it easily decompose and are often found partly living, and partly decayed. It occurs on muddy bottom; and also grows on sticks and other hard substances. The odor of the sponge shown me by Professor Remsen is like that of the water, strongly intensified.”

In giving an account of his examination of certain specimens furnished by the speaker, Professor Farlow said: “The pollution (of the water) seems to me to be caused by the presence of decomposing sponges, the sponge itself actually having been found by me in specimen No. II, and the deposit in No. I having been found to contain numerous sponge spicules, showing that at least sponges had been present. Not being a zöologist, it is beyond my province to say anything further on the subject, except that as a person who has had a certain experience in examining waters with reference to their peculiar odors and tastes, I am perhaps qualified to bear testimony to the identity of the odor emitted by the sponge with that of the water which has given so much trouble of late in Boston, and to the marked intensity of the odor which, as given off by the sponge, was stronger than I had ever before perceived.”

The speaker then continued: “The evidence as will be seen is very strong, almost conclusive, that the sponge is the whole cause of the present difficulty, and probably of many other cases which have been investigated. No one who has had an opportunity to smell the specimens in my possssion could have much doubt regarding the accuracy of this conclusion. The pieces of the sponge caught on the screen were, of course, positive proof of the presence in the pond of larger masses of the same material. It would not take a great deal to contaminate a large body of water. It is believed that the presence of the sponge in Farm Pond furnishes satisfactory explanation of every fact which has been observed in connection with the present condition of the water.” Since the report on the examination was written the water of the pond has been partly drawn off, and large quantities of the sponge have been found growing on rocks on the bottom. Removal of the sponge was recommended, though, as it has remarkable powers of propagation, it is not safe to say what the ultimate effect of removal will be.

The speaker thought it probable that the characteristic taste known as the “cucumber taste” which has been observed so frequently in various parts of this country, and only last winter simultaneously in Boston, New York, and Baltimore, is to be ascribed to the presence of the sponge. Speaking of the Boston water as compared with the bad water which we had here last winter, he said: “It may be instructive to compare the water as it is at present in Farm Pond with that which I examined last spring in Baltimore. As far as I am able to judge, the taste and odor of the two waters are identical, only I do not remember that the Baltimore water ever had these as strongly developed as they are in the pond. In nearly every respect the two waters conducted themselves in the same way. When heated the odor of both was intensified, and the taste of the water on cooling was much improved. On standing for some time, the Farm Pond water loses its odor and taste, as did the Baltimore water. The only difference which I have observed is this: The Baltimore water when passed through a good, large filter of animal charcoal and gravel lost its taste completely, and analysis showed it to be perfectly pure. The Farm Pond water, however, does not, at least with such filters as I was able to procure in Boston, lose its taste entirely when filtered, though it is much improved by the process. I should judge that this difference is only one of degree. The Farm Pond water is certainly much worse than the Baltimore water was at the time I made my examination of it. I have good reason to believe that the contamination of the Baltimore water was of the same nature, as that of the Boston water. In the case of the former, the difficulty disappeared while I was engaged in investigating it. At the time I made my report I expressed the belief that the cause of the odor was no longer operative, and, in a few days after the report was handed in, the trouble disappeared. In the case of the Boston water, however, the cause was undoubtedly operating at the time I made the examination. I cannot but believe that I was particularly fortunate as regards the circumstances under which the investigation was taken up. Had it been taken up later, it is possible and, indeed, judging from the lack of success which has attended earlier attempts to solve the problem, probable, that I would have been obliged to report another failure. But owing largely to the existence of favorable circumstances, the problem is, I believe, at last solved.”

On the Problem of Electrification by Evaporation, by S. H. FREEMAN.

It has been commonly believed that an important source of atmospheric electricity is evaporation.

So far as this belief has an experimental basis it is found in the researches of Pouillet, of Tait, and Wanklyn. Their experiments were made by dashing a few drops of liquid on a red hot platinum crucible, insulated and connected with an electrometer. While the spheroidal state continued little or no change was indicated. As soon as violent vaporization began very decided deflections were obtained. This and other circumstances about the experiments plainly indicate that friction was the chief source of the electrification, and make it very doubtful whether simple evaporation produced any of the observed electrification.

A few months ago the author undertook an investigation to discover whether evaporation alone and under normal conditions causes any electrification and whether such electrification, if any, is sufficient to account for the phenomena of atmospheric electricity.

The apparatus used was a shallow metallic evaporating dish, 19 c. m. in diameter and 1 c. m. in depth, connected with one pair of quadrants of a Thomson's Quadrant Electrometer. The other pair of quadrants and the case of the electrometer were connected with the earth. By means of a mercury commutator the evaporating dish and insulated quadrants could also be connected with the earth. To prevent induction the whole apparatus was inclosed in a metallic case having small openings to show the mirror of the electrometer and to facilitate evaporation. The liquids examined were alcohol, sulphuric ether, water, and solutions of NaCl and of $CuSO_4$. The last three were most carefully studied since these gave Tait and Wanklyn their largest deflections. They obtained

For solution of $CuSO_4$	a potential	800	times that of a Daniel's cell.
“ “ “ NaCl	“ “	120	“ “ “
“ distilled water	“ “	24	“ “ “

The author's experiments last June gave for five minutes insulation of the evaporating dish only about 0.1 the potential of a Daniel's cell.

The deflections obtained from water and a solution of NaCl and from the dry plate were of nearly the same magnitude and always of the same sign. The observations when carefully examined indicated that this small electrification was mainly due to leakage from electrified portions of the apparatus. Several sources of such leakage were detected and later experiments, in which care was taken to make this as small as possible, gave never more than 0.01 and generally less than 0.005 the potential of a Daniel's cell.

The electrometer was thirteen times as sensitive as Professor Tait's. The potentials indicated by the deflections were reduced to absolute measure by comparison with a Daniel's cell. The capacity of the evaporating dish and its connections was determined by comparison with Professor Rowland's standard condenser. The rate of evaporation was found by weighing the dish and liquid before and after each series of experiments. The deflections obtained by the dry plate were also observed.

From these data, for purposes of comparison, the author calculated the virtual depth of water in a thundercloud, which would be required to produce a single flash of lightning, if the cloud were charged as indicated in the experiments. This depth computed for different series gives:

For distilled water	values from	195 c. m.	to	1087 c. m.
“ hydrant	“ “ “	365	“ “	583 “
“ moist cotton		1518 “		
“ solution NaCl	“ “	22	“ “	1782 “
“ “ $CuSO_4$	“ “	183	“ “	1975 “

For distilled water and salt water the charge apparently carried away by the vapor was sometimes positive and sometimes negative. In the other cases it was always positive. The virtual depth of water in a cloud 1500 metres thick if condensation began

At 90° F.	would be about	5 c. m.
“ 80° F.	“ “	4 “
“ 70° F.	“ “	8 “

The experiments then show that evaporation is certainly a very unimportant source of atmospheric electricity and that it is very doubtful whether evaporation causes any electrification whatever.

Philological Association.

November meeting.

Language in its Nature and Origin, by Rev. J. F. McCURDY, of Princeton, N. J.

This paper was an attempt to indicate the scientific basis of a sound philosophy of language. It being postulated, on the one hand, that human speech, as well as human intelligence, is an evolution from the lower animal stage, and, on the other hand, that language in men and animals is simply the *expression* of thought and feeling, the endeavor was made to discover what human language, or true speech, answers to.

An analysis of the intellectual and emotional faculties of men and animals shows that the latter have immediate impressions or ideas of the external world, founded on sense-representation, while the former take these ideas and from them form abstract notions; from perceptions they pass through sensuous ideas to conceptions; from observations to generalizations; from associational inferences to logical reasoning and the formation of judgments. These accomplishments enable men to connote

To take another instance, the comprehension of Roman history depends upon an understanding of Roman law. The technicalities need not be mastered by the historical student, but he should study the doctrines of *imperium*, of *patria potestas*, and discover that the same fundamental conceptions run through both the *jus publicum* and the *jus privatum*. The functions of the praetors, the use made of the Senate by the emperors, the *responsa prudentum*, and the nature of the *jus gentium* should all be understood. The historians of early Rome, Livy, and Dionysius of Halicarnassus, have comparatively little to say about what is really the most interesting thing in Roman history, the growth of law. From a study of Roman institutions and the steady amelioration of the law under the emperors, we obtain a better conception of the real greatness of the Roman empire than from the pages of Tacitus. There are many points in Roman law indicating a higher moral sense than is now recognized by the Anglo-American Common law, *e g.* the refusal to grant an action for breach of promise of marriage, the Roman lawyers holding that to permit such an action would be *contra bonos mores*. It is instructive, again, to observe that the Roman law did not enforce agreements made during life for the settlement of property by will; and yet such agreements are fully recognized by the law of England.

The study of history is perhaps not so immediately useful to the lawyer as that of law to the historian. History, however, will expand the mind of a lawyer and refine his views. Real property law cannot be fully understood without studying the history of feudalism and of early society. Lawyers are often obliged to pursue a historical method in their preparation when they have to advise on a difficult point. They have to trace back the growth and development of some doctrine for a long period of years. They find how the first decision came to be made, and how the leading idea of this decision was developed or modified by later judges who dealt with new sets of circumstances. This kind of historical investigation, actually in use among lawyers, might with profit be applied more fully and comprehensively. One who studies primitive Scandinavian law will have a better understanding of some doctrines of the Common law of England, *e. g.* he will learn that Austin is in error in maintaining that customary law is not law until the courts declare it. The theory of our law is, and the fact is, that the Common law existed before regular State courts, which merely expound what the law was already. And one who studies law historically will perceive that instead of what Austin calls substantive law coming first, and adjective law, or the law of procedure, coming afterwards, it is by forms of procedure that the shape in which substantive rights were recognized came to be given to them. History is of course necessary for the lawyer in order to understand constitutional questions. The comparative method is especially valuable. We can better understand the institutions of England by comparing them with those of Rome. Law is not merely a practical art, but it is also a theoretical science. The framers of constitutions need to be broad-minded men, well versed in the world's history.

December meeting.

History of the Poll-Tax in Maryland, by L. W. Wilhelm.

The notion that a Poll-tax has never been levied in Maryland is a mistake which may be corrected by a study of the statutory law. Such a tax was levied in Maryland as early as 1641, and continued to be levied uninterruptedly down to the last year of the Proprietary government, 1774. In 1641, a capitation tax was granted by the Assembly in testimony of its gratitude toward Lord Baltimore for his efforts in promoting the welfare of the colony. In the Act of 1692, establishing the Protestant religion in Maryland, every taxable was made to pay forty pounds of tobacco yearly for the building of churches and the support of parish ministers. To hinder the growth of papacy, an Act was passed in 1704 taxing all Irish servants who came into the colony. The same year, a tax was imposed on all imported negroes. In 1717, the proceeds of this latter tax were apropriated towards the public school fund and for erecting one free school in each county. In 1728, every taxable was made to present to local authorities, in good old English fashion, three crows-heads or squirrel-scalps. Such taxes promoting the extermination of "vermin" were common in English parishes and in all English colonies. A tax was levied upon old bachelors in 1755, presumably to exterminate this species. Poll-taxes were levied at various times for the building of alms-houses and the construction of highways. The last Poll-tax in Maryland, March, 1774, was for the purpose of building a road through Anne Arundel, Baltimore, and Frederick counties. The Poll-tax, as levied in this province, was never burdensome, nor did it favor the rich at the expense of the poor. Planters' servants, both black and white, were regarded as taxables. The opposition to the Poll-tax expressed in the Declaration of Rights, November 3, 1776, is unaccountable except as a piece of Revolutionary legislation, seeking to break with old English customs. Section 13 declares that "levying taxes by the poll is grievous and oppressive, and ought to be abolished." This declaration is not sustained by a study of the methods of levying the Poll-tax employed in Maryland and of the purposes to which the tax was applied.

Tithingmen, by Herbert B. Adams.

This paper, which was presented at the last meeting of the American Antiquarian Society, October 21, 1881, and which will be published in full in their Proceedings, (New Series, Vol. I, Part 3), shows that the Saxon office of Tithingman, or headship over a neighborhood of at least ten families, was re-instituted in New England in its original simplicity and not as a mere Sunday policeman or ecclesiastical whipper-in, although Sunday duty was an important feature of the Tithingman's office even in old England. But Tithingmen served as policemen on week-days also. They inspected inns and ale-houses. They saw to it that families were well regulated, that children and servants were properly trained, that no idle persons or strolling beggars entered the neighborhood. In Plymouth colony, Tithingmen were instituted in the Indian villages which were subjected to old English parish-law. If an Indian servant ran away from his white master the Tithingman into whose neighborhood the runaway came was obliged to arrest him and hand him over to the "Overseer or next Magistrate, whoe shall cause such servant to be whipt." In the town of Salem Tithingmen or Constables saw to it that no boys escaped from church and that no dogs slunk in. The "Dog-Whipper" was a well-known institution in old English towns, notably in Exeter and Congleton in Chester. Mr. Freeman has called attention to a law of Edgar, (Thorpe, ii, 251), whereby parish priests were to take care that no dog should enter church, nor yet more a swine if it could possibly be hindered. Mr. Freeman also says that Tithings still endure in the Southwest of England. He lives in the Tithing of Burcott, Wells, County of Somerset, which Tithing used to meet and tax itself for local purposes before the recent Highway Act and Poor Law. He confirms our view that there was never any connection between Tithings and Tithes. Arnold, in his History of Rhode Island (ii, 161), is probably in error when he explains Tithingmen as collectors of Tithes. The correspondence of names is purely accidental. Tithingmen are, genealogically speaking, the fathers of Petty Constables (so-called to distinguish them from the High Constable of the Hundred) and the grandfathers of New England Selectmen, who in their lineage are perhaps not very different from Select(vestry)men. In 1638 a bill was introduced into the General Assembly of Maryland providing for "a Tithingman in each Manor" and "a Constable in each Hundred." The Saxon institution of the Hundred, which is but the multiple of the Tithing, is remembered in Maryland and still exists in Delaware in a modified form. These old types of local self-government are connecting links between the English colonies in America and Saxon colonies in England. They should be studied and described before all trace of them is lost.

Mill's Theory of the Taxation of Land, by T. B. Veblen.

With the advance of society the rent of land increases. This increase is independent of any effort on the part of the landlord, being the product of the activity of the community. The State should therefore, by a peculiar tax, appropriate this "unearned increment" and not permit it to go to the owner of the land. To obviate all injustice to owners who have bought land with the expectation of being permitted to enjoy the future increase of its rent, the State is to offer to buy the land of the owners at its market price as an alternative to their keeping it and paying to the State the increase of rent. As a consequence of such an alternative, land having a speculative value would be sold to the State in order to avoid loss to the owners. The measure would act as a fine on the holding of land, to the amount of the speculative value, and lead to an almost universal nationalization of land; differing, however, from generally entertained schemes for the State's getting possession of land, in that the expense of the change would be more equitably distributed on all classes of the community. No immediate redistribution of wealth would take place, but, neglecting all probable undesirable secondary effects of the change on the people, an advantage would accrue from an increased compactness of population, making possible a saving of labor.

Review of Education in Maryland, in Charleston, S. C., and of Dr. Curry's Richmond Address, by Herbert B. Adams.

The report of Professor M. A. Newell, Secretary of the State Board of Education, shows that last year there were 2,089 schools in Maryland, with 158,909 different pupils, 3.180 teachers, and a total expenditure of $1.604,580.77, of which sum $681,921.05 were expended in Baltimore. The report urges more adequate provision for the supply of teachers in the counties.

The City Council of Charleston, S. C., has lately published Mayor Courtenay's review of Education in that State. This review traces the development of the Free School system from its supposed institution in 1811, when $37,000 were appropriated for 123 district schools. In 1880, South Carolina had a school fund of $351,415; 2,973 schools, with 134,072 pupils, 61.219 white and 72,853 colored. The city of Charleston, while receiving $36,057 from the State appropriation, taxes itself, in proportion to its valuation, nearly half as much again for primary education alone as does the city of Boston for its entire school system and, in addition to this, makes an annual appropriation for the support of a High School and of Charleston College. The document is a strong appeal for national aid in the cause of Southern Education through land grants from the public domain, of which, in 1867, there were yet remaining 1,414,567,594 acres. It is suggested that the proceeds of the sale of these lands be distributed by the National Bureau of Education to State officials, as is done by the trustees of the Peabody Education Fund.

In connection with this topic of Southern Education, we note that the recent Richmond address of the Hon. J. L. M. Curry, General Agent of the Peabody Education Fund, on the "Lessons of the Yorktown Centennial" has been printed in pamphlet form. Among the outgrowths of the victory at Yorktown is mentioned the educational system of the United States. In 1880 there were 9,424,086 pupils in the public schools of this country; 366,144 in private schools; and a public school expenditure of $78,201,522. Dr. Curry dwells upon the importance of self-help and local self-government.

January meeting.

The alleged Indebtedness of Adam Smith to the French Economists, by E. R. L. Gould.

Thorold Rogers states that Smith deduced his economic system largely from that of Turgot, while von Scheel goes so far as to prefer the charge of plagiarism against the Scotch economist. The above paper discussed the question under two general heads: (1) The internal evidences gathered from a comparison of those doctrines which appear similar in the writings of Smith and Turgot; (2) General considerations. In pure theory, the "*laissez faire*" of both was alike, but Smith allowed many important exceptions in practice. His was one of utility only, that of Turgot was absolute. The principle of the division of labor was understood by Smith in a sense which never appeared to the French economists. The latter held that land only yielded a revenue; while the former declared that labor was the sole factor in the production of wealth. Upon productive and unproductive labor; upon taxes; upon the expediency of a legal rate of interest; upon the natural price of commodities; upon the measure of value; upon the wages of labor and profits of stock; upon the maintenance of public institutions and the bestowment of the franchise, Smith and Turgot held divergent views. Under the second head, it was shown from manuscript evidence and also from contemporary testimony, that Smith held substantially the same views as those propounded in his "Wealth of Nations," at least one, and possibly seven years previous to the appearance of any of the economic writings of Turgot, and nine years before Quesnay wrote anything of an economic character.

Constables, by Herbert B. Adams.

When the Normans reconstructed England, they did it upon the basis of existing local institutions. Saxon England was already subdivided into a vast number of local, self-governing communities known as Hundreds and Tithings, the latter under the name of Towns and Parishes, deriving their appellation from prominent families or from the environment. The head-man of a Tithing was once called the Tithingman, but he finally became known as the Petty Constable, taking his name from the Norman Lord High Constable (derived, not as Lord Coke said from King and Staple, but from the Byzantine *comes stabuli*, count of the stable, *i. e.* master-of-horse). The shadow of the Roman name fell upon the Saxon Tithingman as upon other Teutonic institutions. The Rolls of Parliament show the Petty Constable in his true historic light: "Chescun Conestable, Tythingman ou chief Plegge de chescun Ville ou Hamell." Originally the chief duty of a Petty Constable, like that of the ancient Tithingman, was to muster the men of his district, and this remained his chief duty as late as the reign of the Tudors. Most of our governing local institutions are the outgrowth of martial beginnings. The mailed leader of the Hundred, says Palgrave, became a rustic peace officer. But Constables and their developed type, the modern Policeman, represent the practical survival of martial authority. They are the sentinels of slumbering society. Let them sound the alarm and the whole community, if necessary, becomes again an armed host. The American Revolution sprang full-armed from Town-Meetings in the North and from Parish-Meetings in the South, both warned by Constables. The origin of municipal institutions in America is more closely connected with Petty Constables than has ever been imagined. By the Common law, the existence of a Constable is the criterion of a Town or Parish. The Constabulary office indicates organic life in a community. The Towns of Plymouth Colony existed potentially in the so-called "Wards" or "Constablewicks" of Duxbury, Scituate, and other places. The first local officer ever chosen at Plymouth was Capt. Miles Standish, who was given "authority to command in affairs." He instituted at once the militia system of old England and was practically Lord High Constable of Plymouth Colony, although for many years he discharged the office of Court Messenger and Petty Constable, until the Town of Plymouth began to differentiate into new Towns. In the Massachusetts Colony, the old English institution of "Constable and Four" was revived by statute law in every Town. This ancient institution is the historic germ of Select Vestrymen and Selectmen, which office is not an American invention, as some writers have supposed. The above paper is to be published in full in the New England Historical and Genealogical Register, April, July, 1882.

The Parish System of South Carolina, by B. J. Ramage.

The earliest form of local self-government in South Carolina was the Parish. It was of English and not of French origin The Parish and its institutions were copied from English models. Like the Parish of old England and the towns of New England, each Parish in Carolina maintained its own roads and poor, and elected its own officers. In the early laws of the colony regulating Parishes, many survivals of old Saxon institutions may be discovered. Like the Tithings and militia of our forefathers, the home guard or patrol of the Parishes in Carolina was organized by *tens*. The Tithing was also reproduced upon the plantations. Every person who owned slaves was to have one white man as overseer over every ten slaves. We also find the Hundred in South Carolina. Laws were passed for the strict observance of the Sabbath according to old English precedent. Rewards were offered for bringing in heads of wild animals and noxious birds according to old English parish usage.

Metaphysical Club.

November meeting.

Theories of Induction, by B. I. Gilman.

A sketch of Aristotle's references to Induction and its use by Socrates was followed by a review of some characteristics of Bacon's theory as exhibited in the Novum Organum. The theory of Dr. Whewell, that Induction consists in the superposition of a clear and appropriate conception upon the facts observed, was alluded to as an account of the conditions of discovery rather than those of proof. An argument was directed against the position of Mr. Jevons that an Inductive conclusion has a calculable probability dependent upon the number of instances observed. The theory of Mill was described as an investigation of the conditions of Inductive proof, in which the process is based primarily upon the Uniformity of Nature, particularly as shown in the Law of Causation, and further upon the fact that our Inductions often have to do with natural kinds where we may expect to find generic characters. The concluding part of the paper embraced a description of the the theory of Probable Inference proposed by Mr. C. S. Peirce.

The paper was followed by some remarks by Mr. C. S. Peirce.

English Deism and the Philosophy of Religion, by G. S. Morris.

Religion subsists—if at all—only in the form of a relation between God as a *Spirit* and man as a *spirit*. There will therefore be no philosophy, or absolute science, of religion, unless the functions of human thought are adapted to the cognition of *spiritual* objects and relations. As matter of historic fact, it may be said that all philosophy proper, (as opposed to agnostic negation of philosophy, on the one hand, and to pure dogmatism, on the other,) has consisted, whether in ancient or modern times, in the demonstration that all knowing is a spiritual activity; that it is a process, the subject of which is a spirit, and which implies, and, in the universe of Being, finds an object or objects cognate with the subject. On the basis of a truly philosophical and objective science of knowledge, therefore, a philosophy of religion seems to be, and is, indeed, possible. It is not possible on any other basis. For the want of such a basis, the movement, known in history under the name of English Deism, and whose only *raison d'être* was the felt need of a philosophy of religion, was crowned with none but negative results. Its principal leaders took the common-places of their "philosophy" from Locke, who saw in knowledge nothing but a mechanical relation between a subject and an object, both of which were *per se* unknowable. The final result of the Deistic movement was therefore necessarily, not knowledge, but scepticism. Or else God was imagined merely as an extramundane *Deus ex machina*, a mechanical "First Cause," between whom and man none but mechanical—*i. e.* no living, spiritual, and truly religious—relations could exist.

January meeting.

E. von Hartmann, by G. Stanley Hall.

In this paper, only a portion of which could be read at one session of the Society, a careful digest of all of Hartmann's writings, down to the end of the Phenomenology of the Moral Consciousness, and those of his disciples and other contemporary German pessimists is made the basis of a critical estimation of pessimism. It was urged that the latter has no claim to be called philosophy; that it is no more connected with the theories of the will or the unconsciousness with which it has been associated, than are the later speculations of A. Comte with the *Philosophie Positive*, and a diagnosis of psycho-pathological elements involved in pessimism was attempted. The Unconscious, derived from a misapprehension of Leibnitz, and of modern analyses of sensations, is also, it was urged, not a philosophical principle, but is used as a handy receptacle for many kinds of residual obscurity, and even in a series of specified cases for individual ignorance. Finally the ethics of pessimism, despite its gratuitous theories of a "tortured absolute" and self-extirpation, etc., contains a wholesome tonic against selfishness, which it seeks to make powerless.

J. S. Mill's Logic, by C. S. PEIRCE.

Mathematical Seminary.

November meeting.

On a Certain Integrable Class of Differential and Finite Difference Equations, by J. J. SYLVESTER.

In Mr. Moulton's edition of Boole's finite-differences will be found quoted from the author of this notice a certain class of equations of which the *general* integral can be found as ex. gr. $\begin{vmatrix} u_x : u_{x+1} \\ u_{x+1} : u_{x+2} \end{vmatrix} = Aa^x$, i. e.,

$u_x u_{x+2} - u^2_{x+1} = Aa^x$, or again $\begin{vmatrix} u_x & u_{x+1} & u_{x+2} \\ u_{x+1} & u_{x+2} & u_{x+3} \\ u_{x+2} & u_{x+3} & u_{x+4} \end{vmatrix} = Aa^x$,

and so on for a persymmetrical determinant of any order (n) constructed on the same principle as the two foregoing ones; an equation of the nth degree and $2n$th order will thus arise.

In this communication to the Seminarium the writer pointed out that an integral (but without any arbitrary constants) may be found for an equation of the same form as that above indicated on the left hand side but with $(n + 1)$ different exponentials instead of a single one on the right hand side as ex. gr. $u_x u_{x+2} - u^2_{x+1} = Aa^x + B\beta^x + C\gamma^x$ can be integrated provided that there are really 3 and not merely 2 distinct terms as would happen if A or B or C were one of them to vanish. But any number of the exponentials may be made indefinitely near to each other and the integral still hold good; in this way other integrable forms of equations can be obtained. As for instance $u_x u_{x+2} - u^2_{x+1} = Aa^x + (B + Cx)\beta^x$, $u_x u_{x+2} - u^2_{x+1} = (A + Bx + Cx^2)a^x$ are integrable.

The same conclusions in all respects apply both as regards the general and the special integral case when any term u_x is replaced by y and u_{x+i} by $\left(\frac{d}{dx}\right)^i y$. The form of the special integral whether for differential or difference equations is rather too long to produce in this abstract but will be given in full in a future number of the *American Journal of Mathematics.*

On the Completion of the Author's Method of Obtaining the Ground-forms to any Binary Quantic or System of Binary Quantics, by J. J. SYLVESTER.

It has sometimes been made a ground of reproach to the method given in the *American Journal of Mathematics* for obtaining the ground-forms to Binary Quantics that it furnishes only the degrees and order, the types so to say of the ground-forms, leaving the forms themselves undetermined. In his communication to the Seminarium, Professor Sylvester pointed out that this reproach is entirely without foundation and he gave a method of obtaining with certainty (and not tentatively), one after another, all the ground-forms of any system of Binary Quantics by means of the knowledge of a complete table of their types. The application of this method is facilitated by a new principle of distribution of the types into natural classes succeeding each other in regular ascending order.

The method is exceedingly simple, consisting almost but not quite exclusively in the application of the well-known partial-differential operator. It will be explained at length in a future number of the *American Journal of Mathematics.*

On a System of Conchordal Conics, by W. E. STORY.

The (triply infinite) system of conics having two points common may be called a system of "conchordal" conics. The common chord passes through two of the intersections of any two conics of the system, and the straight line joining the other two may be called the "radical axis" of the two conics. Then (Salmon's Conic Sections, 5th ed., § 266) the three radical axes of any three conics of the system meet in one point, the "radical centre" of the three conics. By the use of the same form of equation which Salmon has employed (*l. c.*) the following theorems are proved:

I. The six contacts of the tangents to three conchordal conics from their radical centre lie on a conic conchordal with them, their "radical conic."

II. The contacts of the four tangents to any two conics from a point of the line joining either two of their intersections lie on a conic passing through the other two intersections. This is a generalization of the theorem that the tangents to two circles from any point of their radical axis are equal.

III. Each of three conchordal conics is cut by their radical conic so that the tangents at any intersection are harmonic conjugates with respect to the lines joining the intersection to the common points of the conics.

IV. The Jacobian of three conchordal conics consists of their radical conic and their common chord.

V. If the straight lines joining the radical centre with the two common points be given by the equations $x = 0$ and $y = 0$, and the common chord by the equation $z = 0$, then the equation of the radical conic will be $xy - \gamma z^2 = 0$, shewing that *the tangents to the radical conic of three conchordal conics at their common points meet in the radical centre of the three conics*, i. e. *the polar of the radical centre of three conchordal conics with respect to their radical conic is their common chord.*

These theorems are well known but are usually obtained by inference from properties of circles. The analytical method here employed leads readily to numerous properties of binodal quartics, some of which the writer expects to consider at a future meeting.

December meeting.

Analytical Proof of Some Properties of Binodal Quartics, by W. E. STORY.

A binodal quartic may be regarded as the envelope of those conics of a conchordal system having the nodes as common points, which have a common Jacobian conic, and with respect to which the pole of the common chord lies on a fixed conic F (see Salmon's Higher Plane Curves, 2d or 3d ed., § 278). The method of treatment of conchordal conics discussed at the November meeting of the Seminarium was applied to the binodal quartic thus considered, and the following theorems proved:

(*a*) if F touch the Jacobian, the point of contact will be an additional node on the quartic;

(*b*) if F passes through one of the given nodes, that node will be a cusp;

(*c*) if F touch the line joining the nodes, the quartic will degenerate into that line and a cubic through the nodes;

(*d*) if the poles of the line joining the nodes with respect to three of the conics having double contact with the quartic lie on a straight line, the Jacobian will break up into this line and the line joining the nodes.

Note on some Properties of the Numerical Solutions of $ax^2 - y^2 = -1$, by W. P. DURFEE.

If the integral solutions of the equation $ax^2 - y^2 = -1$ be arranged in order of magnitude and be denoted by x_0, y_0; x_1, y_1; x_2, y_2; etc., the following relations were found to hold: —

$$x_n y_{n+t} - x_{n+t} y_n = -x_t,$$
$$ax_n x_{n+t} - y_n y_{n+t} = -y_t.$$

A Geometrical Theorem, by T. CRAIG.

If normals be drawn at all the points of any closed curve in space, and if from the centre of a sphere radii be drawn parallel to the normals to the curve, the extremities of the radii will trace out a curve on the sphere which will divide the surface of the sphere into two equal parts.

January meeting.

On Two Cases of the Quadric Transformation between Two Planes, by ARTHUR CAYLEY.

Seeking for the coordinates x_3, y_3, z_3 of the third point of intersection of the cubic curve $x^3 + y^3 + z^3 + 6lxyz = 0$ by the line through any two points $(x_1, y_1, z_1), (x_2, y_2, z_2)$ on the curve, the expressions present themselves in the form

$$x_3 : y_3 : z_3 = P + 2lA,\ Q + 2lB,\ R + 2lC,$$

where

$$P = x_1 y_1 y_2^2 + z_1 x_1 z_2^2 - y_1^2 x_2 y_2 - z_1^2 z_2 x_2, \quad A = x_1^2 y_2 z_2 - y_1 z_1 x_2^2,$$
$$Q = y_1 z_1 z_2^2 + x_1 y_1 x_2^2 - z_1^2 y_2 z_2 - x_1^2 x_2 y_2, \quad B = y_1^2 z_2 x_2 - z_1 x_1 y_2^2,$$
$$R = z_1 x_1 x_2^2 + y_1 z_1 y_2^2 - x_1^2 z_2 x_2 - y_1^2 y_2 z_2, \quad C = z_1^2 x_2 y_2 - x_1 y_1 z_2^2,$$

but it is known that in virtue of $U_1 = x_1^3 + y_1^3 + z_1^3 + 6lx_1 y_1 z_1 = 0$, $U_2 = x_2^3 + y_2^3 + z_2^3 + 6lx_2 y_2 z_2 = 0$, which connect the coordinates (x_1, y_1, z_1) and (x_2, y_2, z_2) we have $P : Q : R = A : B : C$,* so that the coordinates

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* See Sylvester on Rational Derivation of Points on Cubic Curves. (*Am. Jour. of Math*, *Vol.* 3) [Ed.]

(x_3, y_3, z_3) of the third point of intersection may be expressed indifferently in the two forms

$$x_3 : y_3 : z_3 = P : Q : R \text{ and } x_3 : y_3 : z_3 = A : B, C.$$

But these considered irrespectively of the equations $U_1 = 0$, $U_2 = 0$, are distinct formulae, each of them separately establishing a correspondence between the three points (x_1, y_1, z_1), (x_2, y_2, z_2), (x_3, y_3, z_3) or if we regard one of these points as a fixed point, then a correspondence between the remaining two points, or if we consider these as belonging each to its own plane, then a correspondence between two planes. Writing for convenience (a, b, c) for the coordinates of the fixed point, and (x_1, y_1, z_1) (x_2, y_2, z_2) for those of the other two points, the formulae with A, B, C give thus the correspondence

$$x_2 : y_2 : z_2 = bcx_1^2 - a^2y_1z_1 : cay_1^2 - b^2z_1x_1 : abz_1^2 - c^2x_1y_1,$$

which is the first of the two cases in question. These equations give reciprocally

$$x_1 : y_1 : z_1 = bcx_2^2 - a^2y_2z_2 : cay_2^2 - b^2z_2x_2 : abz_2^2 - c^2x_2y_2,$$

or the correspondence is a (1, 1) quadric correspondence.

The formulae with P, Q, R give in like manner

$$x_2 : y_2 : z_2 = a(ax_1^2 + by_1^2 + cz_1^2) - x_1(a^2x_1 + b^2y_1 + c^2z_1), \text{ \&c.},$$

or if for shortness

$$\Omega_1 = ax_1^2 + by_1^2 + cz_1^2, \quad \Theta_1 = a^2x_1 + b^2y_1 + c^2z_1,$$

then

$$x_2 : y_2 : z_2 = a\Omega_1 - x_1\Theta_1 : b\Omega_1 - y_1\Theta_1 : c\Omega_1 - z_1\Theta_1,$$

which is the second of the two cases. We have reciprocally

$$x_1 : y_1 : z_1 = a\Omega_2 - x_2\Theta_2 : b\Omega_2 - y_2\Theta_2 : c\Omega_2 - z_2\Theta_2,$$

where $\Omega_2 = ax_2^2 + by_2^2 + cz_2^2$, $\Theta_2 = a^2x_2 + b^2y_2 + c^2z_2$,

and the correspondence is thus in this case also a (1, 1) quadric correspondence.

On a Question in Partitions, by J. J. SYLVESTER.

Closely connected with the theory of the contacts or special intersections of quadric figures in space of any number of dimensions, and also with the more general but allied theory of the different genera and species of the roots of unitary matrices, is the question of the number of series that can be formed commencing with zero and ending with a given number i subject to the condition that each intermediate term of any such series shall be not greater than the mean between its antecedent and consequent. By arranging each of the indefinite Partitions of i according to an ascending order of magnitude, it was shown that there was a one to one correspondence between each such arrangement and each such series, and, consequently, that the number of the series is equal to the number of indefinite partitions of the given final term i.

On the Relative Forms of Quaternions, by C. S. PEIRCE.

If X, Y, Z denote the three rectangular components of a vector, and W denote numerical unity (or a fourth rectangular component, involving space of four dimensions), and $(Y : Z)$ denote the operation of converting the Y component of a vector into its Z component, then

$$\begin{aligned} 1 &= (W : W) + (X : X) + (Y : Y) + (Z : Z) \\ i &= (X : W) - (W : X) - (Y : Z) + (Z : Y) \\ j &= (Y : W) - (W : Y) - (Z : X) + (X : Z) \\ k &= (Z : W) - (W : Z) - (X : Y) + (Y : X). \end{aligned}$$

In the language of logic $(Y : Z)$ is a relative term whose relate is a Y component, and whose correlate is a Z component. The law of multiplication is plainly $(Y : Z)(Z : X) = (Y : X)$, $(Y : Z)(X : W) = 0$, and the application of these rules to the above values of $1, i, j, k$ gives the quaternion relations

$$i^2 = j^2 = k^2 = -1, \; ijk = -1, \text{ \&c.}$$

The symbol $a(Y : Z)$ denotes the changing of Y to Z and the multiplication of the result by a. If the relatives be arranged in the block

$$\begin{array}{cccc} W : W & W : X & W : Y & W : Z \\ X : W & X : X & X : Y & X : Z \\ Y : W & Y : X & Y : Y & Y : Z \\ Z : W & Z : X & Z : Y & Z : Z, \end{array}$$

then the quaternion $w + xi + yj + zk$ is represented by the matrix of numbers

$$\begin{array}{cccc} w & -x & -y & -z \\ x & w & -z & y \\ y & z & w & -x \\ z & -y & x & w. \end{array}$$

The multiplication of such matrices follows the same laws as the multiplication of quaternions. The determinant of the matrix = the fourth power of the tensor of the quaternion.

The imaginary $x + y\sqrt{-1}$ may likewise be represented by the matrix

$$\begin{array}{cc} x & y \\ -y & x, \end{array}$$

and the determinant of the matrix = the square of the modulus.

On a Geometrical Proof of a Theorem in Numbers, by J. J. SYLVESTER.

The theorem in question is the well-known one that if a, b are incommensurable and x, y integers $ax + by + c$ may be made positively and negatively indefinitely small. This is tantamount to showing that on the plane of a reticulation,* nodes may be found indefinitely near to and on each side of an irrational straight line, *i. e.* a line not parallel to any line of nodes. The proof is based on the Lemma that no infinite parallelogram, each side of which is an irrational line containing a node, can be vacuous of nodes in its interior. If this were not true a succession of shifts of the figures in the direction of the line forming the two nodes would lead to the absurd conclusion that the whole reticulation consists of a single line of nodes.

1°. Suppose the irrational line L contains a node and that there is no other node at less than a finite distance from it on one side of it, say to the right. Let it be moved to the right parallel to itself until it passes through another node N', then there will be a vacuous parallelogram of the kind declared impossible by the Lemma. [To this it may be objected that when L has moved from the left to M through a distance δ, M might be supposed to be an asymptote to an infinite series of nodes to its right. But if this were the case a node P might be found at a less distance than δ from M, and a node, Q, nearer to M than P is; if this line of nodes PQ be followed up until we reach the first node T on the other side of M, the most elementary geometry seems to show that T in *any* case is nearer to M than P is and consequently there would be a node between L and M contrary to hypothesis.] Hence there must be a node indefinitely near to L on each side of it.

2°. Suppose the irrational line L not to contain a node. If the theorem to be proved is not true, L may as before be moved parallel to itself (through a finite distance) until it pass through a single node and there would be a vacuous parallelogram of which one side contains nodes, which has already been shown to be impossible.

Dr. Story and Dr. Franklin took part in the discussion and the valuable critical observations of the latter, led to the consideration of the objection stated and disposed of in the passage within brackets above. Professor Cayley made a remark to the effect that the diamond point in a graver's tool however fine, drawn in a straight direction across the face of a double grating must either pass through none of the intersections of the two systems of parallel lines or through an infinite number of them. The principle established in the bracketed passage admits of being stated in the following terms: "It is impossible for a straight line in the plane of a reticulation to be asymptotic in regard to nodes on one side of it and not so in regard to the nodes on the other side;" this proposition and the Lemma being conceded, the existence of any indefinite *vacuous* strip bounded by irrational parallel lines is disproved by imagining it distended on both sides, still retaining its form (in case neither bounding line contains a node), or in the contrary case on one side only (*i. e.* in the direction away from the nodal line) until the distended figure passes through two nodes. The asymptotic rule shows that this construction would be possible—the Lemma that it leads to an impossible result. From this it follows that every irrational line is asymptotic in respect to the nodes lying on *each* side of it which is the thing to be proved.

Let a line be termed mono-asymptotic when it is asymptotic in regard to any scheme of points lying on one side of it,—amphi-asymptotic when it is so for schemes of points lying on each side of it. The foregoing argument may then be summed up as follows. Any irrational right line in the plane of a reticulation, must be amphi-asymptotic as regards the nodes. For if not, a line parallel to it must (under pain of contradicting the Lemma) be conceded to exist, which shall be mono-asymptotic in respect to them, but the existence of such a line has been proved to be impossible.† Similarly, it may be shown for a solid network, that no indefinite open prism whose parallel edges are doubly irrational (*i. e.* neither parallel to a nodal line nor to a plane of nodes) can be vacuous of nodes, and also that no plane can be mono-asymptotic—from which, by very similar reasoning to that previously used, may be deduced the law, that no prism of finite dimensions, *vacuous* of nodes, can be constructed about an irrational line as its axis and that consequently any such line may be regarded as a sort of asymptotic axis to a helical spiral of nodes. Hence it follows that if a, b, c (taken two and two) are incommensurable with each other, the quadratic function

$$(b(z-\gamma) - c(y-\beta))^2 + (c(x-\alpha) - a(z-\gamma))^2 + (a(y-\beta) - b(a-\alpha))^2,$$

and as a particular case

$$(bz - cy)^2 + (cx - az)^2 + (ay - bx)^2$$

may be made indefinitely small with integer values of x, y, z.

Nor is this all, for not only can a node be found indefinitely near to the doubly irrational line $x : y : z :: a : b : c$, but such node may be successfully sought for within any infinitesimal sector of space contained within two planes drawn through that line, or in other words a node can be found indefinitely near to the irrational line and to any plane drawn through it, *i. e.* to any plane $bc(m - n)x + ca(n - l)y + ab(l - m)z$, where l, m, n are any quantities whatever,[*] so that x, y, z integer numbers can be found which shall simultaneously cause $(bz - cy)^2 + (cx - az)^2 + (ay - bx)^2$ to be less than any positive quantity k^2 and $(b - c)x + (c - a)y + (a - b)z$ to lie between 0 and h, or 0 and $-h$ where h is also any assigned quantity. And of course the proposition can be stated in more general terms by considering an irrational line which does not pass through a node.

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* By a reticulation is to be understood a pair of systems of an infinite number of indefinite equidistant parallel lines in a plane whose intersections form the nodes.

† The form of proof is a somewhat unusual combination of an *Ex-absurdo* with a *Dilemma*. A *denial* of the amphi-asymptoticism of an irrational straight line either dashes itself against the impossibility of the existence of a vacuous parallelogram or against the equal impossibility of the existence of a mono-asymptotic line.

The same geometrical property admits of being defined under another form, viz., through the assertion that if any two given planes be drawn through a completely irrational line in an infinite Nodal Block,[†] a node may be formed indefinably near to each of them—and this statement translates itself into the arithmetical proposition following:

If no linear equation $\lambda(b\gamma - ca) + \mu(ca - a\gamma) + \nu(a\gamma - ba) = 0$ exists for integer values of λ, μ, ν, the two expressions $ax + by + cz + d$, and $ax + \beta\gamma + \gamma z + \delta$ may simultaneously be made less than any given quantity k, by integer values of x, y, z.

Although it would be difficult to follow the theory of nodal schemes into regions transcending the sensible dimensions of space, there need be no hesitation in accepting the truth of the generalized arithmetical theorem corresponding to this bolder than Icarian flight, viz., that

Any number of linear functions of one more than that number of integer Variables such that the determinant to the Matrix formed by the coefficients of the Variables supplemented by a line of arbitrary integers is incapable of being made zero, can by a right assignment of the Variables be brought to lie each of them between any assigned (indefinitely narrow) limits.

This proposition admits of a partial removal of the condition imposed in the above statement.

For an irrational line even if singly irrational, *i. e.* parallel to a *nodal* plane although not so to a line of nodes, will be asymptotic to a series of nodes *if it lies in a nodal plane*, the only difference in this case being that the nodal sheath will be plain instead of being helical. Hence the two functions $ax + by + cz + d$, $a'x + b'y' + c'z + d'$, can be made simultaneously indefinitely small, even though integer numbers A, B, C, *can* be found such that the determinant $\begin{vmatrix} a & b & c \\ a' & b' & c' \\ A & B & C \end{vmatrix}$ is zero, provided that a rational number D can also be found, which will cause *all* the complete minors of the Matrix $\begin{vmatrix} a & b & c & d \\ a' & b' & c' & d' \\ A & B & C & D \end{vmatrix}$ to vanish.

A particular use of this arises when d and d' are each zero. Consequently the two twin functions $ax + by + cz$ and $a'x + b'y + c'z$, may *in all cases* be made each of them simultaneously to vanish, or else to become indefinitely small for integer values of x, y, z. Thus then, we have an immediate and intuitive proof of Jacobi's celebrated proposition for proving the impossibility of the existence of trebly periodic functions[*]

Those gifted with the powers of a Stringham, a Newcomb, or a Charles S. Peirce to feel their way about in supersensible space, may, in like manner, obtain if not an *intuitive*, at least an immediate, or non-mediated proof of the theorem that: *Any number of* homogeneous *functions of one more than that number of integer variables may be made either* to vanish simultaneously or else *to become simultaneously less than any assignable quantity*.

Whilst in the course of writing out the above matter the following note, addressed to him, from Dr. F. Franklin, was received by Professor Sylvester:

"Your proof may be put into the following form:

Theorem.—In any stripe bounded by irrational parallels there must be a node.

For if not, let N and N' be *any* two nodes. Repeat the stripe a finite number of times, namely, until the aggregate of the stripes shall have included N and N'. No stripe can contain 2 nodes ν, ν', for if it did, by producing $\nu\nu'$ we see that each of the stripes must contain at least one node, which is contrary to the hypothesis. Hence we have an open parallelogram containing 2 nodes N, N', and only a finite number of others, which is absurd; for since the parallelogram intercepts a distance greater than NN', it must intercept on *every* nodal line parallel to NN' at least one node. Thus the theorem is proved.

It may be noted that while a stripe of finite width bounded by *rational* lines contains either no nodes or a *singly* infinite number of them, a stripe bounded by *irrational* lines always contains a *doubly* infinite number of nodes; which, although easily explicable, might at first sight strike one as paradoxical, inasmuch as the probable number in a *given finite portion* is the same for one sort of stripe as for the other."

One word in conclusion. The modes above given of presenting the theory with reference to planes passing through a singly or doubly irrational line ought not to be allowed to draw away attention from the image afforded by a doubly irrational line surrounded by an asymptotic spiral sheath (a point-helix winding round a fish-bellied-torpedo-like bobbin or core) tapering off to an indefinitely fine point in both directions, nor from the extension of the theory of continued fractions to which that image points.

Taking for greater simplicity the case of such a line passing through a node at the origin, the question invites solution to *devise an Algorithm* for finding the integer values of x, y, z which shall give the successive minima (corresponding to nodes of nearest approach) of the function $(bz - cy)^2 + (cx - az)^2 + (ay - bx)^2$, that being the problem next in the order of natural succession to the solved one of finding the successive absolute minima of $ay - bx$.

In the latter case, a and b are supposed to be incommensurable—in the former, no linear equation with rational coefficients is supposed to exist between a, b, c.[†]

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[*] A particular form of this is $(b - c)x + (c - a)y + (a - b)z$. In order to give the theorem its greatest generality it is only necessary to substitute for x, y, z, $x - \alpha$, $y - \beta$, $z - \gamma$ where α, β, γ, are any real qualities whatever.

[†] By a Nodal Block is to be understood three systems in space of an indefinite number of equidistant parallel planes whose intersections are the nodes.

[*] See M. Hermite's admirable "*Note sur le calcul differential et le calcul intégral*," Paris, 1862, pp. 5–8, where the proposition in question is established by means of the theory of ternary and binary quadratic forms.

[†] Which is tantamount to saying that the line $x : y : z :: a : b : c$ must be doubly irrational.

NOTE FROM THE BIOLOGICAL LABORATORY.

On the Effects of a Gradual Rise of Temperature upon Reflex Actions in the Frog.

Dr. M. Foster, (Journal of Anatomy and Physiology, viii, 45, 1874), after investigation, has concluded that the headless frog sits quiet in water, when heated gradually up to rigor, because the heat depresses the functional power of the spinal cord, thus precluding any reflex movement due to the thermal stimuli. He admits that this involves a physiological paradox, since organs having a protoplasmic basis ordinarily exhibit, like protoplasm itself, a phase of exaltation of function on the application of heat before final loss of function under excessive heat; and in this case no such phase of exaltation occurs. He accepts certain observations made upon the frog's heart by Mr. T. O. Harding and thinks that in that case we have a parallel exception, since in Harding's observations it was found that a frog's heart, which, outside the body, always beats faster under a higher temperature, and slower under a lower temperature, if heated indirectly, within the body, by immersing only the legs in water the temperature of which is gradually raised, invariably beats slower without any previous phase of exaltation.

Hence Dr. Foster concludes that there is a difference between direct and indirect heating in their effects upon function—a belief to which he felt himself driven by his own experiments upon the spinal cord and the experiments of Mr. Harding upon the heart. The whole matter is so much at variance with other phenomena that a new study of it seemed desirable.

This has been undertaken with the following results:—

1. Harding's experiments (which were accepted by Dr. Foster) are inconclusive: because, (the brain and spinal cord having been destroyed), owing to vaso-motor paralysis and gravity, the blood in such cases settles away into the legs and visceral veins; the heart becomes empty, pale, flabby, and starved; and the result is no circulation. This is apparent enough to the observer but is put beyond doubt by a thermometer placed upon the heart or in the alimentary canal near by.

2. Hence we must conclude that the heart is not heated at all (either directly or indirectly) and goes slower—not because of heat, but from lack of food; or possibly from negative pressure, causing imperfect diastole. The conclusion drawn by Dr. Foster from Harding's work cannot be sustained; viz —that indirect heating is, physiologically, unlike direct heating in its effects. All attempts to get a slower heart-beat under indirect heating have failed whenever the heart is actually heated.

3. The quiet of the frog is not due to a depression of functional power caused by heat in the spinal cord; for if the excitability of the cord be determined just before and just after heating it will be found nearly the same in both cases, although in the one the cord is cool; in the other many degrees warmer. The same fact is established by other experiments which cannot be given here.

4. In Dr. Foster's paper (of which this is mostly a review) the suggestion is made and discarded that the cause of the seeming dullness of the quiet frog may be "the uniform stimulation of a large surface." This seems to be the true explanation; though such stimulation must be brought about by the aid of the circulation which, by cooling the immersed parts and warming those not immersed protects the cord from stimuli so unlike as to produce a reflex movement. The proof of this is seen in tying the heart of a headless frog and heating the immersed legs as in other cases. All circulation having ceased, the difference between the stimuli from the skin of the legs and of the parts not wetted, speedily becomes sufficient to produce a series of movements—some of which begin at a low temperature.

The subject will be treated in full elsewhere and experiments in support of the foregoing statements will be brought forward.

W. T. SEDGWICK.

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

Published here.

American Chemical Journal. Edited by Professor Remsen. *Vol. III. No. 3.* June, 1881.

Article I.—Chemical Action in a Magnetic Field:—I. On the Deposition of Copper on Iron in a Magnetic Field. By Ira Remsen.

To determine whether magnetism exerts an influence upon chemical action various experiments were tried. The most striking and interesting results were obtained by placing thin iron vessels on the poles of magnets and then pouring into the vessels a solution of copper sulphate. Metallic copper is of course deposited upon the iron; but instead of appearing as a uniform layer, as it would, were the magnet not present, it is deposited in curious lines. The general conclusion thus far reached is stated thus: "When copper is deposited from a solution of copper sulphate on a plate of iron in a magnetic field, it is arranged in ridges around the poles of the magnet, and in directions which are at right angles to the lines of force, and, consequently, coincident with the lines marking the equipotential surfaces. Further, the outlines of the poles of the magnet are always sharply defined on the plate, as along these lines a portion of the iron of greater or less width is left unacted upon."

The experiments will be continued with the view of determining, if possible, whether the phenomena observed are due to the action of magnetism on the iron plate, on the solution, or on both.

Article II.—Determination of Chromium in Chrome Iron Ore. By H. N. Morse and W. C. Day.

Chrome iron ore is very stable and resists to an unusual degree the action of reagents. Hence, its analysis involves serious difficulties to overcome which various efforts have been made. The authors of this paper describe a simple method devised by them which effects the desired object more readily than any other method thus far used. It consists in fusing the ore with potassium hydroxide for several hours. The compound is in this way completely decomposed and at the same time oxidized, forming potassium chromate. The chromium is estimated as chromic oxide. Several analyses are reported the results of which are concordant.

Article III.—On Furfurol and Certain of its Derivatives. By Henry B. Hill.

This is the conclusion of the paper of the same title, two previous instalments of which have appeared and been reported upon. The special subjects taken up in this instalment are: mucochloric acid; dichloracrylic acid; substituted acrylic acids from brompropiolic acid; iodbromacrylic acid; tribromacrylic acid; theoretical considerations.

Article IV.—Dinitroparadibrombenzols and their Derivatives. By W. D. Schoonmaker and J. A. Van Mater.

A description of some experiments to determine the influence of mixtures of sulphuric and nitric acids of different strengths on the relative quantities of isomeric products formed in a given case. A case of "atomic migration" is also briefly discussed.

Article V.—On the Molecular Weight of Hydrofluoric Acid. By J. W. Mallet.

The experiments of Gore have shown that at temperatures near 100° hydrofluoric acid exists as HF, and the atomic weight of fluorine is thus established as 19. At lower temperatures, however, certain measurements of the gaseous acid, which have been made, represent distinctly smaller volumes. Hence it seemed still desirable to try to ascertain whether the acid exhibits a different, but definite vapor density at a temperature nearer the boiling point, though high enough to preclude any actual liquid acid remaining, operating in quantities large enough to give decisive results with even rough weighings, and if possible in transparent or translucent vessels. The experiments described in the paper are very interesting. The figures obtained obviously justify the assumption that at 30° C. the molecule of hydrofluoric acid vapor should be represented not as HF, but as H_2F_2, since the agreement with this assumption of the vapor density obtained in the two experiments is too close to be fairly accounted for by the mere general idea of imperfect gaseous condition, and it is certain that no such quantity of actually liquid acid as would be necessary to account for the double weight could possibly have escaped detection on the inner surface of the flask. At higher temperatures, such as those at which Gore's measurements were made, dissociation manifestly takes place, leading to the production of diatomic molecules of HF.

Article VI.—Some Double and Triple Oxalates containing Chromium. By F. W. Clarke.

Article VII.—The Titration of Tartaric, Malic, and Citric Acids with Potassium Permanganate. Communicated by F. W. Clarke.

Article VIII.—Relation between Temperature and the Rate of Chemical Action. By R. B. Warder.

This is a brief preliminary note in which it is shown that the speed of the reaction,

$$C_2H_5.O.C_2H_3O + NaOH = NaC_2H_3O_2 + C_2H_5.OH,$$

in dilute aqueous solution, has been observed at temperatures from 8.6° to 37.7° C. This series of determinations nearly agrees with the equilateral hyperbola,

$$(7.5 + a)\ (62\ 5° - t) = 521.4,$$

where t is the temperature, and a expresses the number of gram-equivalents per liter which would (according to the theory of the action of mass) react upon each other per minute in a solution kept of normal strength.

Article IX.—Oxidation of Sulphaminemetatoluic Acid in Alkaline and in Acid Solution. By R. D. Coale and Ira Remsen.

The mixture of the amides of *a*- and *β*-metaxylenesulphonic acids obtained by the usual processes from commercial xylene was oxidized with chromic acid mixture, and converted into sulphaminemetatoluic acid, which was obtained in pure condition without difficulty. The acid was then oxidized with potassium permanganate directly, without the addition of an alkali. The product obtained was sulphoisophthalic acid, $C_6H_3\left\{\begin{array}{l}SO_3H\\CO_2H.\\CO_2H\end{array}\right.$ Several salts of the acid were prepared, and the analyses of these showed that the acid is tribasic. On now oxidizing sulphaminemetatoluic acid with potassium permanganate, adding a little more than enough caustic potash to neutralize the acid, the product formed was sulphamineisophthalic acid, or rather the corresponding sulphinide, $C_6H_3\left\{\begin{array}{l}SO_2NH\\CO\lrcorner\\CO_2H\end{array}\right.$. By neutralizing the aqueous solution of this substance with various carbonates, the corresponding salts of sulphamineisophthalic acid were obtained. These salts differ markedly from those of sulphoisophthalic acid.

Sulphoisophthalic acid was also obtained by direct oxidation of xylenesulphonic acid.

Article X.—Concerning Mesitylenic Sulphinide. By Ira Remsen and P. H. Broun.

As has been shown in earlier papers, when mesitylene sulphamide is oxidized with chromic acid, only one of the methyl groups present is converted into carboxyl. It was at first thought that the particular group transformed must be that which is in the para position with reference to the sulphamide group, and that the ortho-methyl groups are protected. Further investigation has shown that the first conclusion was incorrect, and that in reality the group which is oxidized is one of the ortho-methyls. This is the more remarkable, as it has been shown that, in the case of the corresponding nitro- and bromine derivatives of mesitylene, the acid groups do actually protect the ortho methyls.

Report on Progress in Physiological Chemistry. By R. H. Chittenden.

The special subject discussed in this report is:

Salivary Digestion and the Products formed: Rapidity of Conversion of Starch into Sugar; Action of Saliva in the Stomach.

Report on Analytical Chemistry. By H. N. Morse.

Recent improvements in analytical methods as applied to the following substances are discussed: *Zinc; Cadmium; Silver; Mercury; Nickel and Cobalt; Iron; Aluminum; Manganese.*

Notes: Note to paper "Alkalimetry with Phenol Phthalein as Indicator," by R. B. Warder; *Precipitation of Ammonium Phospho-molybdate in presence of Salts of Organic Acids,* by J. W. Mallet.

Article II.—On Certain Expansion Theorems. By EMORY MCCLINTOCK.

"Any function fy can be expanded in terms of x, if $y = x\phi y$, provided fy and ϕy can be expanded in terms of y, and ϕy does not vanish with y." Giving the reason for this, the author derives the following theorem without difficulty, putting $\mathrm{D} = \frac{d}{dy}$:

$$fy = fy_{[y=o]} + x.\phi y \mathrm{D} fy_{[y=o]} + \tfrac{1}{2}x^2.\mathrm{D}(\phi y)^2 \mathrm{D} fy_{[y=o]} + \dots \tag{1}$$

Comparing this series with others already known, he concludes thus: "We have, then, in (1) a series which is essentially identical with those of Lagrange and Bürman, which is simpler in form than either, and which is at once a connecting link between them and a necessary step in the most direct demonstration of both. The inference seems warranted that we should regard it as the main proposition, of which the others are corollaries." Among these and other corollaries instanced, the following is given as new: "To expand fu in terms of fu, find some expression of the form $\Psi^{-1}u - a$ which will exactly divide fu. Then

$$fu = f\Psi a + fu.\frac{y-a}{f\Psi y}\mathrm{D}f\Psi y + \frac{1}{1.2}(fu)^2.\mathrm{D}\left(\frac{y-a}{f\Psi y}\right)^2\mathrm{D}f\Psi y + \dots_{[y=a]}.\text{”}$$

Another deduction from (1) is a third new series, chiefly useful in computing the coefficients required in the reversion of series.

Article III.—Some Theorems in Numbers. By O. H. MITCHELL.

The first section of this article treats of the residues, mod k, of the symmetric functions of the numbers less than k, where $k =$ any integer. An abstract of this section is given in University Circular, No. 12, under the proceedings of the Mathematical Seminary

The second section extends the results of the preceding section, and the results of an article on Binomial Congruences in the preceding number of the Journal, to the theory of functions (mod. $p, f(x)$).

If $f(x) = K \equiv A^t B^u \dots G^v H^w \dots Q^z$, mod. p, where p is a prime number. t, u, &c. are any integers, and A, B, &c. are irreducible (mod. p) functions of x of forms $x^a + \lambda_1 x^{a-1} + \lambda_2 x^{a-2} +$ &c.. $x^b + \mu_1 x^{b-1} + \mu_2 x^{b-2} +$ &c., respectively, if $S = H \dots Q$, and $\tau_S(K)$ denote the number of functions of less degree than K which contain S (mod. p) but do not contain any factor of K not found in S, *i. e.* the number of the *S-totitives* of K, then

$$\tau_S(K) = p^k\left(1-\frac{1}{p^a}\right)\left(1-\frac{1}{p^b}\right)\dots\left(1-\frac{1}{p^q}\right),$$

where $k =$ the degree of K, $= a + b + \dots + q$.

The properties of the roots of $X^2 \equiv X$ (mod. p, K) are shown to be the same as the properties of the roots of $x^2 \equiv x$ mod. k, where $k =$ any integer.

The analogue of the generalized Fermatian theorem is seen to be

$$X_S^{\tau_S(K)} \equiv R_S \text{ (mod. } p, K),$$

where X_S is any S-totitive of K. and R_S is that one of the roots of $X^2 \equiv X$ (mod. p, K) which is an S-totitive of K.

If $X'_S, X''_S, \dots X_S^{[\tau_S(K)]}$ be the S-totitives of K, then

$$\Sigma X'_S X''_S \dots X_S^{[m]} \equiv (-)^{\frac{m}{\tau(\bar{A})}} R_{\bar{A}} C^{\tau_{\bar{A}S}(K)}_{\frac{m}{\tau(\bar{A})}} + \dots$$

$$\dots + (-)^{\frac{m}{\tau_1(\bar{G})}} R_{\bar{G}} C^{\tau_{\bar{G}S}(K)}_{\frac{m}{\tau(\bar{G})}}, \text{ (mod. } p, K),$$

where $\bar{A} = B \dots Q$, C is a binomial coefficient, and only those terms of the summation are to be taken for which $\frac{m}{\tau(\bar{A})}$, *i. e.* $\frac{m}{p^a - 1}$, = an integer.

When $m = \tau_S(K)$ the formula becomes

$$\Sigma X'_S \dots X_S^{[m]} \equiv R_{\bar{A}} + R_{\bar{B}} + \dots + R_{\bar{G}} \equiv R_{\overline{AB\dots G}} = R_S \text{ (mod. } p, K),$$

except when $\frac{AB \dots Q}{S} =$ an irreducible function, as A, and p is not 2, in which case $\frac{\tau(K)}{p^a - 1}$ is odd, and we have

$$\Sigma X'_S \dots X_S^{[m]} \equiv -R_S \text{ (mod. } p, K).$$

This special case of the formula constitutes the analogue of the generalized Wilsonian theorem.

Article IV.—Note on the Frequency of use of the Different Digits in Natural Numbers. By SIMON NEWCOMB.

"That the ten digits do not occur with equal frequency must be evident to anyone making much use of logarithmic tables, and noticing how much faster the first pages wear out than the last ones." By a simple investigation it is shown that "the law of probability of the occurrence of numbers is such that all mantissae of their logarithms are equally probable;" in other words, that "every part of a table of anti-logarithms is entered with equal frequency." Hence a table is easily computed showing the relative frequency of the several digits in the first place of figures, in the second place, &c.

Article V.—Tables of the Generating Functions and Groundforms of the Binary Duodecimic, with some General Remarks, and Tables of the Irreducible Syzygies of Certain Quantics. By J. J. SYLVESTER.

This paper contains tables for the Binary Quantic of the 12th order, to a similar extent and in the same form as the tables for the 6c, 7c, 8c, 9c, 10c, which have previously appeared in the Journal.

It also contains complete tables of the degrees and orders of the syzygies connecting the groundforms of the Quintic, the Sextic, and a simultaneous system of a Quadric and Cubic.

In addition to certain observations on permanent as distinguished from transient ground-differentiants, it gives an *aperçu* of a general method for deducing from the generating function to any system of Binary Quantics the complete system of types of the groundforms and the syzygants of the various grades, by a uniform algebraical process which operates directly on the generating function regarded in the light of an ordinary algebraical fraction, without any regard to the particular form that may be assigned to its numerator and denominator by the introduction or suppression of a common factor.

Article VI.—A Demonstration of the Impossibility of the Binary Octavic possessing any Groundform of deg-order 10.4. By J. J. SYLVESTER.

In this article it is conclusively established that the covariant of order 4 and degree 10 appertaining to the Binary Octavic found by Dr. von Gall, and which he has been unable to decompose, must notwithstanding be decomposable; inasmuch as it is proved that if any groundform whatever to the Binary Octavic of such a deg-order existed, the number of linearly independent covariants of that deg-order would exceed 32, the number given by Cayley's Rule. This form then in Dr. von Gall's final enumeration being suppressed, his results are brought into exact accordance with the table given in the Journal, Vol. II, p. 233.

Article VII.—On the Logic of Number. By C. S. PEIRCE.

In this paper the most fundamental properties of the elementary operations with numbers are strictly deduced from a few primary propositions belonging to the more general field of the logic of relatives. The associative, commutative, and distributive laws are proved, the proof in each case consisting "in showing, 1st, that the proposition is true of the number one, and 2nd, that if true of the number n it is true of the number $1 + n$, next larger than n."

Article VIII.—On the Remainder of Laplace's Series. By EMORY MCCLINTOCK.

The remainder of fy after $n + 1$ terms, putting $y = f(z + x\phi y)$ and $\mathrm{D} = \frac{d}{dz}$, is $\frac{1}{n!}\mathrm{D}^n\int_{fz}^{y}(x\phi t + z - f^{-1}t)^n f't.dt.$

Studies from the Biological Laboratory. Edited by PROFESSOR MARTIN. Associate Editor, DR. W. K. BROOKS. Contents of *Vol. II, No.* 2. (In press.)

List of Medusæ found at Beaufort, N. C., during the Summers of 1880 *and* 1881. By W. K. BROOKS.

On the Origin of the so-called "Test-cells" in the Ascidian Ovum. By J. PLAYFAIR MCMURRICH. With one plate.

A Contribution to the Study of the Bacterial Organisms commonly found upon Exposed Mucous Surfaces and in the Alimentary Canal of Healthy Persons. By GEORGE M. STERNBERG. With three plates.

A Fatal Form of Septicæmia in the Rabbit, Produced by the Subcutaneous Injection of Human Saliva. By GEORGE M. STERNBERG. With one plate.

Experiments with Disinfectants. By **George M. Sternberg.**

Observations on the Direct Influence of Variations of Arterial Pressure upon the Rate of Beat of the Mammalian Heart. By **H. Newell Martin.** With one plate.

The Influence of Changes of Arterial Pressure upon the Pulse Rate in the Frog and the Terrapin. By **Wm. H. Howell** and **Mactier Warfield.** With one plate.

Notes on the Development of Arbacia Punctulata. By **B. P. Colton** and **H. Garman.** With two plates.

On the Structure and Significance of some Aberrant Forms of Lamellibranchiate Gills. By **K. Mitsukuri.** With one plate.

Observations on the Early Developmental Stages of some Polychætous Annelids. By **Edmund B. Wilson.** With four plates.

The Origin of the Eggs of Salpa. By **W. K. Brooks.** With one plate.

American Journal of Philology. Edited by **Professor Gildersleeve.** Contents of *No.* 8. (In press.)

The forthcoming number (No. 8) will complete the second volume. It contains articles by Professor **Robinson Ellis** on the *Fragments of Sophokles*, by Professor **C. L. Smith** on *Virgil's Instructions for Crops*, by Professor **C. H. Toy** on **A** *in Semitic*, by Professor **Shepherd** on the *Position of the Rhematic* **to** *in English*, by Professor **McCurdy** on *Assyriology*, and by the **Editor** on *πρίν in the Attic Orators*; *Notes* by Mr. **Thomas Davidson**, *Reviews*, *Reports*, *Recent Publications*, and a full *Index* to the volume.

ENGLISH UNIVERSITIES.

Abstract of a recent Lecture before the Students of the Johns Hopkins University, by James Bryce, M.P., D.C.L., Regius Professor of Civil Law in the University of Oxford, England.

England now has five universities; formerly there were only two. Scotland has four, two having been united. Oxford and Cambridge have existed for many centuries as fully appointed universities. The university of London is not properly a university, but merely an examining body for granting degrees, and it does that kind of work thoroughly. The university of Durham is new and not yet prominent. The new university at Manchester is the outgrowth of Owens College and was originally endowed, like the Johns Hopkins, by a private founder, afterwards by subscriptions. It has become known chiefly by its work in natural science but desires to encourage humanistic studies equally. We anticipate a great future for it. None of the English or Scotch universities are denominational; none have now (since 1871) religious tests, except that the established church in both England and Scotland has possession of the theological faculties. English universities are self-governed, except London and Manchester. which are controlled respectively by a senate (named by the Crown) and by a board of trustees. The constitutions of Oxford and Cambridge are very complicated and are understood by nobody outside the universities and by few inside. Ancient usage, modern Acts of Parliament, and their own legislation have all gone to the making of them. These university governments have two modern assemblies, called in Oxford "Convocation" (made up of alumni having degrees) and "Congregation" (made up of graduates resident in the university town). These latter appoint the University Council, and all university statutes must pass through the three bodies.

In the matter of teaching, the Scotch universities are much like American colleges. The methods are catechetical; teaching is regarded as more important than examinations; prizes are in vogue and exercise great influence. In Scotland, prizes are usually awarded by vote of the students. Practically the system works better than would awards by the professors. Prizes generally go where they belong. The Scotch universities are cheap, because the fees are low and the students live where they please. Their conspicuous and distinctive merit lies in the great stimulative power of their teaching. In England there is, with less of this stimulus, perhaps more of finished scholarship and greater opportunities for an enjoyable social life. There are three sets of teachers in the English universities: (1) the professors, who have hitherto taken a part in the teaching more dignified than practically important, except in natural science, where they have had nearly all the work to do; (2) the tutors and lecturers, who bear the burden of practical work and give their instruction in connection with some college independent of the university proper; (3) private tutors, or "coaches," from whom forty years ago came nearly all the instruction at English universities, but who are now much less active, because both university professors and college teachers have become far more efficient than they were then. In England, examinations have become the main thing, and practically control the teaching, although the true view of them would rather be that they should exist as a test of teaching. The examinations, though very old, had become purely formal in the last century: their present importance is comparatively recent. In the Cambridge Triposes, students have heretofore (for a change is now being made) been arranged according to merit. At Oxford the arrangement has been into classes, according to merit, the successful men being arranged alphabetically in each class, so that it is not known, unless the examiners give private information, where a man really stands in the class he has reached. Students are the more ambitious to reach as high a class as possible, because fellowships and success, in such a profession as schoolmastering, depend, to a considerable extent, upon such rank.

The fellowships yield from $750 to $1,000 a year. Most of them are at Oxford awarded for proficiency in the same studies as are required at the examinations in the various schools of the university. There is hence difficulty in England in causing students to follow any lecture course or branches of liberal culture which do not count towards their examinations in the schools, or towards a fellowship. Among the practical university problems of the day are: (1) the reduction of expenses for students. The necessary cost at an English university is from $600 to $1,000 a year. (2) The creation of a more complete system of preparation for the leading professions. Something has been done towards the promotion of training for clergymen and for lawyers. Oxford and Cambridge have deficient facilities for medical training, because the towns are too small to support great hospitals. Natural science is now everywhere encouraged. (3) Ampler provision is required for teaching in a great number of more recondite subjects, and encouragement should be given to men, who do not intend to pass through the whole university course, to come and attend lectures in these subjects. (4) Something should be done to enable the university to help original research, and to increase the number of residents who devote themselves to the pursuit of learning. At present large funds are wasted in what are called "prize-fellowships." Unfortunately the land revenues of the colleges have suffered from the competition of Western America, and money is wanting to carry out some of the most desirable improvements. Broadly considered, the advantages of English university education may be said to consist in the combination of college and university life. The Scotch universities afford efficient class teaching; the German universities give the fullest instruction by professional lectures; the English universities excel in social advantages and in opportunities for forming valuable friendships. The excessive development of their examination system has certainly injured their teaching; but it has been improving in compass as well as in earnestness, and seems likely to improve still further.

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HENRY A. ROWLAND. Physics. 14 *Cathedral St.*

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D. C. L., University of Oxford, 1870; LL. D., University of Cambridge, 1874.

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CHARLES L. WOODWORTH, JR. Elocution. 180 *Linden Av.*

Amherst College; Boston University School of Oratory, 1875.

GENERAL STATEMENTS.

Instruction is provided for both University and Collegiate students. Courses may always be expected in the following subjects:

Mathematics,
Physics,
Chemistry,
Biology,
Logic,
Philosophy,
History,
Political Economy,
Comparative Philology,
Sanskrit,
Greek,
Latin,
Romance Languages,
Teutonic Languages,
English.

The charge for tuition is eighty dollars per year. There is an additional fee for material, etc., in the Laboratories. Board and lodging in private houses near the University may be obtained at five or six dollars, and upwards, per week.

The Register will be issued near the end of the academic year, and will give full information as to the plans and work of the University. Announcements of proposed lectures, courses of instruction, etc., appear in the *University Circulars*, and are separately issued from time to time.

The Calendar for the year 1881-82 is given on page 171.

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CALENDAR, 1881–82.

April 7—10.	**Spring Recess.**
June 5—8.	**Matriculation Examinations.**
June 9.	**Term of Instruction Closes.**
September 19.	**Next Academic Year Begins.**
September 20—23.	**Matriculation Examinations.**
September 26.	**Instructions Resumed.**

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MEETINGS OF SOCIETIES.

Scientific. First Wednesday of each month, at 8 P. M. Next meeting, April 5.
S. H. Freeman, Secretary.

Philological. First Friday of each month, at 12 M. Next meeting, April 7.
M. Warren, Secretary.

Metaphysical. Second Tuesday of each month, at 8 P. M. Next meeting, April 11.
B. I. Gilman, Secretary.

Historical and Political Science. Third Friday of each month, at 8 P. M. Next meeting, April 21.
H. B. Adams, Secretary.

Mathematical. Third Wednesday of each month, at 8 P. M. Next meeting, April 19.
O. H. Mitchell, Secretary.

Naturalists' Field Club. Excursions each Saturday during the Spring and Autumn. Regular meetings for the reading and discussion of papers once a month.
H. F. Reid, Secretary.

LIST OF OFFICERS AND STUDENTS, 1881-82.

TRUSTEES.

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237 St. Paul St.

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138 St. Paul St.

George William Brown,
89 W. Chase St.

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187 St. Paul St.

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A. B., Princeton College, 1849, and A. M., 1852; Ph. D., University of Göttingen, 1853; LL. D., College of William and Mary, 1869; Professor of Greek in the University of Virginia, 1856-76; Professor of Latin in the University of Virginia, 1861-66.

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M. B., University of London, 1871, and Dr. Sc., 1872; A. B., University of Cambridge, 1874; and A. M., 1877; Fellow, and late Lecturer on Natural History in Christ College, Cambridge; Fellow of University College, London; M. D., (Hon.) University of Georgia, 1881.

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Fellows.

illiam J. Alexander. Hamilton, Ont. *156 W. Biddle St.*
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mes W. Bright. Lock Haven, Pa. *83 Garden St.*
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iase Palmer. Baltimore. *96 W. Townsend St.*
A. B., Johns Hopkins University, 1879. *Chemistry.*

erbert M. Perry. New Ipswich, N. H. *263 N. Howard St.*
A. B., Harvard University, 1880. *Mathematics.*

ward H. Spieker. Baltimore. *123 N. Paca St.*
A. B., Johns Hopkins University, 1879. *Greek.*

enry N. Stokes. Moorestown, N. J. *24 McCulloh St.*
S. B., Haverford College, 1878. *Biology.*

orrison I. Swift. Ashtabula, O. *218 Linden Av.*
A. B., Williams College, 1879. *Philosophy.*

njamin W. Wells. Boston, Mass. *43 Cathedral St.*
A. B., Harvard University, 1877, and Ph. D., 1880. *English.* (*Resigned, October,* 1881.)

Graduate Students.

William H. Adkins. Easton. *117 N. Charles St.*
A. B., Johns Hopkins University, 1882. *History.*

Thomas Atkinson. Baltimore. *164 W. Madison St.*
B. Litt., University of Virginia, 1880, and A. M., 1881. *Latin.*

Edward Barnes. Northboro, Mass. *28 McCulloh St.*
S. B., Worcester Free Institute, 1879. *Mathematics.*

Thomas M. Beadenkopf. Baltimore. *14 S. Chester St.*
A. B., Johns Hopkins University, 1880. *Sanskrit.*

Charles J. Bell. Boston, Mass. *48 Cathedral St.*
University of Munich. *Chemistry.*

Edward W. Bemis. Springfield, Mass. *156 W. Biddle St.*
A. B., Amherst College, 1880. *History.*

John C. Bland. Philadelphia. *Philadelphia.*
C. E., Member Am. S. C. E. *Mathematics.*

DeWitt B. Brace. Lockport, N. Y. *28 McCulloh St.*
A. B., Boston University, 1881. *Physics and Mathematics.*

J. H. Branham. Baltimore. *30 N. Calvert St.*
M. D., College of Physicians and Surgeons, (Balt.,) 1879. *Biology.*

Philip H. Broun. Middleburg, Va. *119 W. Madison St.*
University of Virginia, 1876. *Chemistry.*

Buel P. Colton. Princeton, Ill. *251 W. Fayette St.*
A. B., Amherst College, 1874. *Biology.*

Herbert W. Conn. Fitchburg, Mass. *28 McCulloh St.*
A. B., Boston University, 1881. *Biology and Chemistry.*

Ellery W. Davis. Oconomowoc, Wis. *156 W. Biddle St.*
S. B., University of Wisconsin, 1879. *Mathematics.*

David T. Day. Baltimore. *207 Madison Av.*
A. B., Johns Hopkins University, 1881. *Chemistry.*

Frank Donaldson. Baltimore. *108 Park Av.*
A. B., Harvard University, 1879. *Biology.*

James R. Duggan. Macon, Ga. *367 Eutaw Place.*
A. B., Mercer University, 1877, and A. M., 1880; M. D., Jefferson Medical College, 1879. *Chemistry and Biology.*

Herman L. Ebeling. Catonsville. *150 N. Eutaw St.*
A. B., Johns Hopkins University, 1882. *History and German.*

William S. Fleming. Wetumpka, Ala. *268 N. Howard St.*
A. B., Davidson College, 1878. *Greek and Latin.*

Harry E. Gale. Baltimore. *224 W. Hoffman St.*
A. B., Maryland Agricultural College, 1881. *Biology and Chemistry.*

Arthur H. Giles. Manlius, N. Y. *214 W. Biddle St.*
A. B., Syracuse University, 1878. *Greek and Latin.*

Henry R. Goodnow. Brooklyn, N. Y. *209 N. Howard St.*
A. B., Amherst College, 1878. *Physics.*

Elgin R. L. Gould. Oshawa, Ont. *125 Park Av.*
A. B., Victoria University, 1881. *History and Political Science.*

James G. Hamner. Parkersburg, W. Va. *185 St. Paul St.*
A. B., Marietta College, 1881. *Greek and Latin.*

Otto F. T. Hanser. Baltimore. *62 N. Fremont St.*
Concordia College, 1878. *Greek and Latin.*

Graeme Harrison. Baltimore. *90 Read St.*
A. B., Princeton College, 1881. *Romance Languages.*

Arthur S. Hathaway. Decatur, Mich. *205 N. Howard St.*
S. B., Cornell University, 1879. *Mathematics.*

Erasmus Haworth. Boston Mills, Kan. *54 McCulloh St.*
S. B., Kansas State University, 1881. *Chemistry and Physics.*

B. Lewis Hobson. Lexington, Mo. *28 McCulloh St.*
A. B., Central University, (Ky.,) 1877, and A. M., 1880. *Greek and Sanskrit.*

Andrew Holstad. Decorah, Io. *172 W. Biddle St.*
A. B., Norwegian Luther College, 1881. *Greek and Latin.*

William H. Howell. Baltimore. *433 N. Mount St.*
A. B., Johns Hopkins University, 1881. *Biology.*

Edward Ingle. Baltimore. *358 Linden Av.*
A. B., Johns Hopkins University, 1882. *Greek, etc.*

Hans C. G. Jagemann. Naumburg, Germany. *255 N. Eutaw St.*
Naumburg Gymnasium, 1876. *Modern Languages.*

Oakley A. Johnson. Hackettstown, N. J. *8 McCulloh St.*
S. B., Rutgers College, 1881. *History and Political Science.*

Edward H. Keiser. S. B., Swarthmore College, 1880, and S. M., 1881. *Chemistry and Physics.*	Allentown, Pa.	28 *McCulloh St.*
Frederic S. Lee. A. B., St. Lawrence University, (N. Y.,) 1878, and A. M., 1881. *Biology.*	Canton, N. Y.	92 *Saratoga St.*
William J. Loudon. A. B., University of Toronto, 1880. *Physics.*	Toronto, Ont.	19 *McCulloh St.*
Charles T. MacClintock. A. B., Kentucky Wesleyan College, 1881. *Logic and Philosophy.*	Millersburg, Ky.	367 *Eutaw Place.*
William D. MacClintock. A. B., Kentucky Wesleyan College, 1878, and A. M., 1881. *English.*	Millersburg, Ky.	367 *Eutaw Place.*
Robert W. Mahon. C. E., Lehigh University, 1876. *Chemistry.*	Bethlehem, Pa.	186 *N. Exeter St.*
Thomas W. Mills. A. M., University of Toronto; M. D., McGill University; M. R. C. P. (Eng.) *Biology.*	Montreal, Canada.	150 *N. Eutaw St.*
William N. Mumper. A. B., Dickinson College, 1879. *Physics and Chemistry.*	Dillsburg, Pa.	253 *N. Caroline St.*
Keating S. Nelson. A. B., St. John's College, 1874; A. M., University of Virginia, 1878. *Greek.*	Albemarle Co., Va.	267 *N. Eutaw St.*
Chalmers C. Norwood. A. B., Davidson College, 1878. *Mathematics.*	Fort Valley, Ga.	268 *N. Howard St.*
William A. Noyes. A. B., Iowa College, 1879. *Chemistry and Physics.*	Grinnell, Io.	209 *W. Biddle St.*
Clapham Pennington. M. D., University of Maryland, 1882. *Chemistry.*	Baltimore.	86 *W. Eager St.*
Charles A. Perkins. A. B., Williams College, 1879. *Physics.*	Ware, Mass.	28 *McCulloh St.*
Walter B. Platt. Ph. B., Yale College, 1874; M. D., Harvard University, 1879; M. R. C. S. (Eng.) *Biology.*	Baltimore.	74 *Cathedral St.*
Burr J. Ramage. A. B., Newberry College, 1880. *History and Political Science.*	Newberry, S. C.	217 *N. Howard St.*
Harry F. Reid. A. B., Johns Hopkins University, 1880. *Physics and Mathematics.*	Baltimore.	75 *Mt. Vernon Place.*
Samuel Sale. Ph. D., University of Heidelberg, 1878. *Sanskrit.*	Baltimore.	86 *N. Stricker St.*
Albert Shaw. A. B., Iowa College, 1879. *History and Political Science.*	Grinnell, Io.	209 *W. Biddle St.*
John Sieber. A. B., German Wallace College, Ohio, 1881. *Greek and Latin.*	Baltimore.	178 *S. Wolfe St.*
William C. Thayer. A. B., Columbia College, 1876. *Latin and Sanskrit.*	New York City.	182 *W. Madison St.*
Andrew A. Veblen. A. B., Carleton College, (Minn.,) 1877, and A. M., 1880. *Mathematics.*	Northfield, Minn.	129 *S. Patterson Park Av.*
Thorstein B. Veblen. A. B., Carleton College, (Minn.,) 1880. *Philosophy and Political Science.*	Northfield, Minn.	218 *Linden Av.*
Mactier Warfield. A. B., Johns Hopkins University, 1881. *Biology.*	Baltimore.	112 *St. Paul St.*
Henry C. Warren. A. B., Harvard University, 1879. *Sanskrit.*	Boston, Mass.	182 *W. Madison St.*
Lewis W. Wilhelm. A. B., Johns Hopkins University, 1880. *History and Political Science.*	Baltimore.	64 *Pennsylvania Ave.*

Members of the Historical Seminary.

In addition to ten elsewhere enrolled.

Henry J. Bowdoin. A. B., Johns Hopkins University, 1881.	Baltimore.	180 *N. Charles St.*
Daniel L. Brinton. Friends' High School.	Baltimore.	45 *Forrest Place.*
Edgar Goodman. A. B., Johns Hopkins University, 1880.	Baltimore.	41½ *Pennsylvania Av.*
John Johnson. A. B., Johns Hopkins University, 1881.	Owings Mills.	*Owings Mills.*
Stewart B. Linthicum. A. B., Johns Hopkins University, 1880.	Baltimore.	131 *W. Lanvale St.*
John H. Lowe. A. B., Johns Hopkins University, 1880.	Baltimore.	387 *Madison Av.*
Daniel M. Murray.	Baltimore.	108 *Cathedral St.*

Members of the Chesapeake Zoölogical Laboratory.

SESSION OF 1881.

In addition to two elsewhere enrolled.

James E. Armstrong. S. B., Illinois Industrial University, 1881, and Assistant in Natural History.	Champaign, Ill.
J. Playfair McMurrich. Assistant in Biology, University of Toronto.	Toronto, Ont.
William L. Norris.	Arlington, Ill.
Henry J. Rice. S. B., Cornell University, 1876, and S. M., 1880; Fellow of Johns Hopkins University, 1876-78; Professor of Natural Science, Michigan Military Academy.	Orchard Lake, Mich.
Fernando Sanford. Professor of Natural Science, Mount Morris College.	Mount Morris, Ill.

MATRICULATES.

Albert C. Applegarth.* Baltimore City College.	Baltimore.	632 *W. Fayette St.*
William S. Bayley. Baltimore City College, 1879.	Baltimore.	641 *W. Lombard St.*
T. Alexis Berry. Dr. R. Atkinson's School.	Baltimore.	247 *Bolton St.*
John P. Campbell.* Andrew Small Academy.	Darnestown.	352 *N. Eutaw St.*
Walter B. Canfield. Mr. G. G. Carey's School.	Baltimore.	48 *Cathedral St.*
George G. Carey, Jr. Mr. G. G. Carey's School.	Baltimore.	265 *N. Eutaw St.*
William K. Cromwell. Mr. H. W. Luckett, Instructor.	Baltimore Co.	94 *W. Lombard St.*
Charles W. R. Crum. Franklin and Marshall College.	Jefferson.	67 *N. Liberty St.*
Henry Duffy. Baltimore City College.	Baltimore.	82 *Townsend St.*
Maurice Fels. Mr. E. Cohen, Instructor.	Philadelphia.	20 *Pearl St.*
Charles Frick.* Baltimore City College.	Baltimore.	400 *Park Av.*
Harry Friedenwald. Baltimore City College.	Baltimore.	88 *N. Eutaw St.*
Louis Garthe. Baltimore City College, 1880.	Baltimore.	98 *Hill St.*
D. Sterrett Gittings. Mr. H. W. Luckett, Instructor.	Baltimore.	145 *N. Charles St.*
John Glenn, Jr. Mr. G. G. Carey's School.	Baltimore.	348 *N. Eutaw St.*
William L. Glenn. Mr. G. G. Carey's School.	Baltimore.	158 *N. Charles St.*
Basil B. Gordon. Mr. H. W. Luckett, Instructor.	Baltimore.	27 *Franklin St.*
William J. Guard. Friends' Academy.	Baltimore.	150 *Park Av.*
John Hinkley. Mr. G. G. Carey's School.	Baltimore.	287 *N. Charles St.*
Lindley M. Huggins.* Friends' High School.	Baltimore.	*St. Paul St. extended.*
E. F. Keerl. Mr. W. S. Marston, Instructor.	Baltimore.	*Lafayette Av.*
George T. Kemp. Baltimore City College.	Baltimore.	55 *N. Greene St.*
Richard F. Kimball. Mr. C. P. Grady's School.	Baltimore.	87 *Park Av.*
Gustav A. Liebig, Jr. Mr. E. Deichmann, Instructor.	Baltimore.	307 *St. Paul St.*
Rudolph A. Liebig. Mr. E. Deichmann, Instructor.	Baltimore.	307 *St. Paul St.*
Gonzales Lodge. Baltimore City College, 1881.	Baltimore.	210 *N. Gilmor St.*
John D. Lord, Jr. Mr. M. A. Newell, Instructor.	Baltimore.	205 *N. Carrollton Av.*

C. W. EMIL MILLER. Baltimore City College, 1880.	Baltimore.	806 *S. Sharp St.*
EDGAR G. MILLER, JR. Friends' Academy.	Baltimore.	279 *W. Baltimore St.*
WILLIAM R. ORNDORFF.* Baltimore City College, 1881. *Chemistry.*	Baltimore.	18 *Lorman St.*
JAMES PAGE. Baltimore City College.	Baltimore.	81 *W. John St.*
ALBERT G. PALMER. Friends' High School.	Baltimore.	172 *McCulloh St.*
GEORGE D. PENNIMAN.* Baltimore City College.	Howard Co.	117 *W. Monument St.*
WILLIAM H. PERKINS. Mr. W. S. Marston's School.	Baltimore.	207 *Franklin St.*
ROBERT M. REESE. Friends' High School.	Baltimore.	209 *W. Pratt St.*
L. BAYARD ROBINSON.* Baltimore City College.	Baltimore.	16 *Brown St.*
FRANCIS ROTCH.* Mr. W. S. Marston's School.	Ilchester.	182 *W. Madison St.*
LEWIS T. STEVENS. Baltimore City College.	Baltimore.	105 *Charles St. Av.*
GEORGE C. STOKES, JR. Dr. J. C. M. Mérillat, Instructor.	Govanstown.	*Govanstown.*
WILLIAM E. STRATTON.* Baltimore City College.	Baltimore.	66 *N. Liberty St.*
HERBERT T. TIFFANY. Mr. S. E. Turner, Instructor.	Baltimore.	85 *Bolton St.*
HENRY W. WILLIAMS. Mr. W. S. Marston's School.	Baltimore.	60 *Franklin St.*
HENRY V. WILSON. Baltimore City College.	Baltimore.	814 *Linden Av.*
WILLIAM J. WITZENBACHER.* Washington County High School.	Hagerstown.	28 *McCulloh St.*

* Conditionally.

NON-MATRICULATES.

Course Preliminary to the Study of Medicine.

Graduates and Matriculates pursuing this course are enrolled above.

JOHN T. HYSLOP. Mr. G. G. Carey's School.	Pungoteague, Va.	182 *Mulberry St.*
JERE W. LORD. Mr. M. A. Newell, Instructor.	Baltimore.	205 *N. Carrollton Av.*
HERBERT L. PRICE. Baltimore City College.	Baltimore.	70 *Bolton St.*
ROBERT L. RANDOLPH. U. S. Military Academy.	Baltimore.	140 *St. Paul St.*
HENRY M. THOMAS. Haverford College.	Baltimore.	817 *Madison Av.*
I. RIDGWAY TRIMBLE. Shenandoah Valley Academy.	Longwood.	241 *Maryland Av.*

Special Students.

GUSTAV BISSING. Baltimore City College. *Mathematics.*	Baltimore.	264 *W. Lombard St.*
WILLIAM CASPARI, JR. Maryland College of Pharmacy, 1881. *Chemistry.*	Baltimore.	245 *Argyle Av.*
THOMAS L. COLE. Virginia Theological Seminary. *Languages, etc.*	Orange, N. J.	19 *McCulloh St.*
ARTHUR T. COLLINS. *Chemistry and Physics.*	Bristol, Pa.	*Mt. Washington.*
J. HOLMES CONVERSE. Racine College. *Greek and Latin.*	Baltimore.	*Bar Library.*
W. BENTON CRISP. Mr. F. Knapp's Institute. *History, Languages, etc.*	Baltimore.	59 *Harlem Av.*
DANIEL B. DORSEY. Baltimore City College. *History, etc.*	Baltimore.	205 *Franklin St.*
HARRISON GARMAN. Illinois State Normal University. *Biology.*	Normal, Ill.	251 *W. Fayette St.*
MAURICE GREGG. Mr. W. S. Marston's School. *History.*	Baltimore.	155 *N. Charles St.*
W. BEATTY HARLAN. St. John's College. *Chemistry.*	Churchville.	247 *Linden Av.*
THOMAS J. LEFTWICH. Bingham School. *Philosophy.*	Baltimore.	140 *Park Av.*
JOHN MACCLINTOCK. Kentucky Wesleyan College. *History, etc.*	Millersburg, Ky.	367 *Eutaw Place.*
ORMSBY L. MAHON. Baltimore City College. *Chemistry.*	Baltimore.	186 *N. Exeter St.*
CHARLES T. MCDANIEL. Baltimore City College, 1881. *Greek and Philosophy.*	Baltimore.	428 *W. Fayette St.*
NICHOLAS M. PARRISH. Steuart Hall. *Mathematics.*	Baltimore.	336 *N. Gilmor St.*
PHILIP M. PRESCOTT. Dartmouth College. *Philosophy.*	Waukegan, Ill.	48 *Cathedral St.*
FREDERICK PUND. Mr. C. P. Grady's School. *Chemistry.*	Baltimore.	232 *N. Gay St.*
T. HENRY RANDALL. St. John's College. *Physics.*	Annapolis.	365 *N. Charles St.*
CHARLES D. STICKNEY. *English and History.*	New Bedford, Mass.	*St. James Hotel.*
PERCY H. TAYLOR. Princeton College. *Romance Languages.*	Baltimore Co.	257 *Linden Av.*
WILLIAM WALZ. Baltimore City College, 1881. *Languages.*	Baltimore.	288 *E. Madison St.*
HENRY H. WIEGAND. Baltimore City College. *Chemistry.*	Baltimore.	272 *Madison Av.*
GEORGE WHITELOCK. *Romance Languages.*	Baltimore.	142 *N. Charles St.*

SUMMARY.

President and Professors,	7
Lecturers,	11
Associates,	16
Assistants,	9
	43

ENROLLED STUDENTS.

Graduate Students (including Fellows),	95
Matriculates,	44
Non-Matriculates,	31
Total Enrolled,	170

Classification by Residence of Students, 1881-82.

Maryland, (Baltimore, 80),	94
New York,	12
Massachusetts,	10
Pennsylvania,	7
Illinois,	6
New Jersey,	5
Ontario,	5
Iowa,	3
Kentucky,	3
Virginia,	3
Ohio,	3
Georgia,	2
Minnesota,	2
Michigan,	2
New Hampshire,	1
Connecticut,	1
West Virginia,	1
South Carolina,	1
Alabama,	1
Wisconsin,	1
Kansas,	1
Missouri,	1
California,	1
Quebec,	1
France,	1
Japan,	1
Germany,	1

Students enrolled above have been Graduated in the Institutions below named:

Johns Hopkins University,	18
Amherst College,	6
Harvard University,	5
Toronto University,	3
Virginia, University of,	3
Williams College,	3
Yale College,	3
Boston University,	2
Carleton College, (Minn.),	2
Columbia College,	2
Cornell University,	2
Davidson College,	2
Iowa College,	2
Kentucky Wesleyan College,	2
Marietta College,	2
Rutgers College,	2
Victoria University,	2
Central University, (Ky.),	1
Concordia College,	1
Dickinson College,	1
France, University of,	1
Freiburg, University of,	1
German Wallace College, (Ohio),	1
Hamilton College,	1
Haverford College,	1
Heidelberg, University of,	1
Illinois Industrial University,	1
Jefferson Medical College,	1
Kansas State University,	1
Lafayette College,	1
Lehigh University,	1
London, University of,	1
Maryland Agricultural College,	1
Maryland, University of,	1
McGill University,	1
Mercer University,	1
Michigan, University of,	1
Newberry College,	1
Norwegian Luther College,	1
Physicians and Surgeons, (Balt.)	1
Princeton College,	1
Rochester, University of,	1
St. John's College,	1
St. Lawrence University,	1
Swarthmore College,	1
Syracuse University,	1
Tokio, University of,	1
Wesleyan University,	1
Wisconsin, University of,	1
Worcester Free Institute,	1

ENUMERATION OF CLASSES, SECOND HALF-YEAR, 1881–82.

Mathematics. (33 Students).

Classes meet in Room 16.

Mathematical Seminary: Professor Sylvester, Professor Cayley, Dr. Story, and Dr. Craig. Third Wednesday of each month, 8 P. M. (17).

Barnes.
Bissing.
Bland.
Brace.
Davis.
Durfee.
Ely, G. S.
Franklin.
Gilman, B. I.
Hathaway.
Ladd.
Mitchell.
Norwood.
Perry.
Prentiss.
Preston.
Witzenbacher.

Multiple Algebra: Professor Sylvester. Twice weekly, Tuesday and Friday, 4 P. M. (12).

Bissing.
Craig.
Durfee.
Ely, G. S.
Franklin.
Gilman, B. I.
Hathaway.
Ladd.
Mitchell.
Perry.
Prentiss.
Story.

Algebraical Geometry, and the Abelian and Theta Functions: Professor Cayley. Twice weekly, Monday and Thursday, 4 P. M. (14).

Bissing.
Craig.
Davis.
Durfee.
Ely, G. S.
Franklin.
Hathaway.
Ladd.
Mitchell.
Norwood.
Perry.
Prentiss.
Preston.
Story.

Quaternions: Dr. Story. Thrice weekly, Tuesday, Wednesday, and Friday, 10 A. M. (5).

Barnes.
Davis.
Durfee.
Gilman, B. I.
Norwood.

Solid Analytic Geometry: *Advanced Course:* Dr. Story. Thrice weekly, Monday, Thursday, and Friday, 9 A. M. (1).

Davis.

Higher Plane Curves: *Elementary Course:* Dr. Story. Thrice weekly, Monday, Wednesday, and Thursday, 1 P. M. (3).

Veblen.
Williams.
Witzenbacher.

Elliptic Functions: Dr. Craig. Thrice weekly, Monday, Wednesday, and Thursday, 1 P. M. (3).

Durfee.
Ely, G. S.
Norwood.

Elasticity: Dr. Craig. Thrice weekly, Tuesday, Wednesday, and Friday, 11 A. M. (4).

Barnes.
Brace.
Koyl.
Perry.

Partial Differential Equations: Dr. Craig. Thrice weekly, Monday and Thursday, 11 A. M.; Tuesday, 9 A. M. (9).

Barnes.
Brace.
Durfee.
Ely, G. S.
Freeman.
Goodnow.
Norwood.
Perry.
Reid.

Modern Algebra: Dr. Franklin. Twice weekly, Monday and Thursday, 10 A. M. (6).

Brace.
Davis.
Durfee.
Ely, G. S.
Freeman.
Ladd.

Integral Calculus: Dr. Franklin. Thrice weekly, Tuesday, Wednesday, and Friday, 11 A. M. (8).

Applegarth.
Huggins.
Perkins, C. A.
Perkins, W. H.
Veblen.
Wiegand.
Williams.
Witzenbacher.

Theory of Equations: Dr. Franklin. Thrice weekly, Tuesday, Wednesday, and Friday, 10 A. M. (8).

Applegarth.
Crum.
Liebig, G. A.
Page.
Perkins, W. H.
Veblen.
Williams.
Witzenbacher.

Physics. (35 Students).

Classes meet in Rooms 3, 4, 7, 8.

Theory of Heat Conduction: Professor Rowland. Four times weekly, Monday, Tuesday, Wednesday, and Friday, 12 M. (7).

Brace.
Freeman.
Goodnow.
Koyl.
Mumper.
Perry.
Reid.

Theory of Sound: Professor Rowland. To begin March 15.

Laboratory Work: Professor Rowland. Daily. (7 advanced students).

Brace.
Freeman.
Goodnow.
Koyl.
Mumper.
Perkins, C. A.
Reid.

Major Course: Dr. Hastings. Lectures weekly, Thursday, 8 P.M.; Laboratory work during week, especially Wednesday. (10).

Barnes.
Broun.
Day, W. C.
Johnson.
Keiser.
Mumper.
Noyes.
Page.
Perkins, C. A.
Reid.

General Physics: Dr. Hastings. Daily, 10 A. M. (20).

Cole.
Dorsey.
Frick.
Friedenwald.
Glenn, W. L.
Guard.
Haworth.
Huggins.
Kemp.
Lord, J. D.
Lord, J. W.
Miller, C. W. E.
Miller, E. G.
Palmer, A. G.
Penniman.
Randall.
Reese.
Stokes, G. C.
Trimble.
Wilson, H. V.

Laboratory Work: (*Class in General Physics*). Dr. Hastings and Mr. Freeman. (13).

Cole.
Dorsey.
Frick.
Friedenwald.
Glenn, W. L.
Haworth.
Kemp.
Lord, J. W.
Palmer, A. G.
Randall.
Stokes, G. C.
Trimble.
Wilson, H. V.

Chemistry. (39 Students).

Classes meet in the Chemical Laboratory.

Laboratory Work: Professor Remsen and Drs. Morse and Coale. Daily. (36).

Applegarth.
Bayley.
Bell.
Berry.
Bissing.
Broun.
Collins.
Comstock.
Conn.
Crisp.
Day, D. T.
Day, W. C.
Duggan.
Frick.
Friedenwald.
Gale.
Gittings.
Harlan.
Haworth.
Keiser.
Kemp.
Liebig, R. A.
Lord, J. W.
Mahon, O. L.
McClintock, C. T.
Noyes.
Orndorff.
Palmer, C.
Pennington.
Pund.
Randolph.
Rotch.
Stokes, H. N.
Stratton.
Wiegand.
Wilson, H. V.

Chemistry of Carbon Compounds: Professor Remsen. Four times weekly, Monday, Tuesday, Wednesday, and Thursday, 9 A. M. (17).

Bayley.
Broun.
Caspari.
Comstock.
Conn.
Day, W. C.
Duggan.
Gale.
Harlan.
Haworth.
Keiser.
Lee.
Mahon, O. L.
Noyes.
Pund.
Stratton.
Wiegand.

Principles of Thermo-Chemistry: Professor Remsen. Weekly, Friday, 12 M. (12).

Bell.
Broun.
Comstock.
Day, D. T.
Day, W. C.
Duggan.
Haworth.
Keiser.
Noyes.
Palmer, C.
Pund.
Stokes, H. N.

General Chemistry: *Metals:* Dr. Morse and Dr. Coale. Daily, 9 A. M. (15).

Applegarth.
Berry.
Collins.
Crisp.
Frick.
Friedenwald.
Gittings.
Kemp.
Liebig, R. A.
Lord, J. W.
McClintock, C. T.
Orndorff.
Randolph.
Rotch.
Wilson, H. V.

Mineralogy: Dr. Morse. Twice weekly, Thursday and Friday, 10 A. M. (11).

Bayley.
Day, D. T.
Day, W. C.
Duggan.
Garthe.
Harlan.
Haworth.
Keiser.
Mahon, O. L.
Palmer, C.
Wiegand.

Biology. (20 Students).

Classes meet in the Biological Laboratory.

Physiology of the Circulation: Professor Martin. Monday, 11 A. M.; Thursday, 10 A. M. (8).

Branham.
Colton.
Donaldson, F.
Donaldson, H. H.
Garman.
Howell.
Stokes, H. N.
Warfield.

Animal Physiology: Dr. Sewall. Three times weekly, Monday, Tuesday and Friday, 10 A. M.—Professor Martin: weekly examination, Wednesday, 10 A. M. (9).

Branham.
Colton.
Conn.
Donaldson, H. H.
Garman.
Lee.
Osborn.
Stevens.
Stokes, H. N.

Mammalian Anatomy: Dr. Brooks. Twice weekly, Tuesday and Thursday, 9 A. M. (3).

Stevens.
Trimble.
Warfield.

Comparative Osteology: Dr. Brooks. Twice weekly, Monday, and Thursday, 11 A. M. (9).

Colton.
Conn.
Gale.
Garman.
Lee.
Liebig, G. A.
Osborn.
Stratton.
Thomas.

General Biology: Dr. Sedgwick. Three times weekly, Wednesday, Thursday, and Friday, 11 A. M.—Professor Martin: examination on alternate Wednesdays, 11 A. M. (11).

Colton.
Duggan.
Gale.
Garman.
Lee.
Liebig, G. A.
MacClintock, C. T.
Osborn.
Stratton.
Thomas.
Trimble.

Laboratory Work: Professor Martin, Dr. Sewall, Dr. Sedgwick. Daily. (20).

Branham.
Colton.
Conn.
Donaldson, F.
Donaldson, H. H.
Duggan.
Gale.
Garman.
Howell.
Lee.
Liebig, G. A.
MacClintock, C. T.
Osborn.
Platt.
Stevens.
Stokes, H. N.
Stratton.
Thomas.
Trimble.
Warfield.

Greek. (34 Students).

Seminary: Professor Gildersleeve. Weekly, Wednesday, 12 M., Room 13. (11).

Alexander.
Burgess.
Fleming.
Giles.
Hamner.
Hobson.
Nelson.
Nicolassen.
Short.
Sieber.
Spieker.

Plato's Symposion: *Lectures:* Professor Gildersleeve. Weekly, Monday, 12 M., Room 13. (12).

Alexander.
Burgess.
Fleming.
Giles.
Hamner.
Hobson.
Nelson.
Nicolassen.
Short.
Sieber.
Spieker.
Thayer.

Plato: *Cursory Reading:* Professor Gildersleeve. Weekly, Tuesday, 10 A. M., Room 13. (8).

Alexander.
Burgess.
Fleming.
Giles.
Hobson.
Short.
Sieber.
Spieker.

Lectures on Literature: Professor Gildersleeve. Weekly, Thursday, 12 M., Room 18. (11).

Alexander.
Burgess.
Fleming.
Giles.
Hamner.
Hobson.
Nelson.
Nicolassen.
Short.
Sieber.
Spieker.

Greek Philosophy: (*Ritter and Preller.*) Professor Gildersleeve. Weekly, Friday, 10 A. M., Room 18. (8).

Alexander.
Burgess.
Fleming.
Giles.
Hobson.
Short.
Sieber.
Spieker.

Comparative Grammar of Greek: Dr. Bloomfield. Weekly, Wednesday, 4 P. M. (9).

Alexander.
Bright.
Burgess.
Hobson.
Nicolassen.
Short.
Spieker.
Thayer.
Warren, H. C.

Sophocles: *Ajax:* ***Lyric Selections:*** Professor C. D. Morris. Four times weekly, Monday, Wednesday, Thursday, and Friday, 9 A. M., 187 North Howard Street. (8).

Cole.
Glenn, W. L.
Holstad.
Hamner.
Lodge.
McDaniel.
Tiffany.
Walz.

History: *Special Course:* Professor C. D. Morris. Weekly, Tuesday, 12 M. (2).

Ingle.
Tiffany.

Metres (*Greek and Latin*)*:* Professor C. D. Morris. Weekly, Saturday, 11 A. M., 187 North Howard Street. (12).

Canfield.
Cromwell.
Duffy.
Hinkley.
Garthe.
Hobson.
Lodge.
Lord, J. D.
Miller, E. G.
Penniman.
Perkins, W. H.
Walz.

Homer: *Odyssey:* Mr. Nicolassen. Four times weekly, Tuesday, Wednesday, Thursday, and Friday, 11 A. M., Room 8, 198 North Eutaw Street. (7).

Campbell.
Canfield.
Glenn, J.
Guard.
Miller, E. G.
Robinson.
Stokes, G. C.

Prose Composition:

Class A. Professor C. D. Morris. Weekly, Tuesday, 9 A. M., 187 North Howard Street. (8).

Cole.
Glenn, W. L.
Hamner.
Holstad.
Lodge.
McDaniel.
Tiffany.
Walz.

Class B. Mr. Nicolassen. Weekly, Monday, 11 A. M., Room 8, 198 North Eutaw Street. (7).

Campbell.
Canfield.
Glenn, J.
Guard.
Miller, E. G.
Robinson.
Stokes, G. C.

Latin. (34 Students.)

Seminary: Vergil: Dr. Warren. Twice weekly, Tuesday and Friday, 4 P. M., 187 North Howard Street. (7).

Alexander.
Atkinson.
Burgess.
Fleming.
Giles.
Hobson.
Thayer.

Latin Inscriptions: Dr. Warren. Weekly, Thursday, 4 P. M., 187 North Howard Street. (9).

Alexander.
Atkinson.
Burgess.
Fleming.
Giles.
Hobson.
Sieber.
Spieker.
Thayer.

Terence; Plautus: Dr. Warren. Four times weekly, Monday, Wednesday, Thursday, and Friday, 11 A. M., Room B, 118 West Monument Street. (8).

Glenn, W. L.
Holstad.
Keerl.
Kimball.
Sieber.
Thayer.
Tiffany.
Warren, H. C.

Juvenal; Martial; Pliny: Professor C. D. Morris. Four times weekly, Monday, Wednesday, Thursday, and Friday, 10 A. M., 187 North Howard Street. (5).

Canfield.
Cromwell.
Duffy.
Lodge.
Walz.

Horace: Mr. Nicolassen. Four times weekly, Tuesday, Wednesday, Thursday, and Friday, 9 A. M., Room 5, 193 North Eutaw Street. (14).

Carey.
Garthe.
Glenn, J.
Gregg.
Guard.
Hinkley.
Lord, J. D.
Miller, E. G.
Penniman.
Perkins, W. H.
Robinson.
Stokes, G. C.
Williams.
Witzenbacher.

Prose Composition.

Class A. Dr. Warren. Weekly, Tuesday, 11 A. M., Room B, 118 West Monument Street. (6).

Glenn, W. L.
Holstad.
Keerl.
Kimball.
Sieber.
Tiffany.

Class B. Professor C. D. Morris. Weekly, Tuesday, 10 A. M., 187 North Howard Street. (5).

Canfield.
Cromwell.
Duffy.
Lodge.
Walz.

Class C. Mr. Nicolassen. Weekly, Monday, 9 A. M., Room 5, 193 North Eutaw Street. (14).

Carey.
Garthe.
Glenn, J.
Gregg.
Guard.
Hinkley.
Lord, J. D.
Miller, E. G.
Penniman.
Perkins, W. H.
Robinson.
Stokes, G. C.
Williams.
Witzenbacher.

Sanskrit. (5 Students). Dr. Bloomfield.

Classes meet in Room 5, 193 North Eutaw Street.

Kathâsaritsâgara: Twice weekly, Monday and Thursday, 4 P. M. (2).

Bright.
Warren, H. C.

Gṛhya-sutra: Twice weekly, Tuesday and Friday, 4 P. M. (1).

Warren, H. C.

Elementary: *Nala.* Thrice weekly, Monday and Friday, 3 P. M.; Wednesday, 5 P. M. (3).

Hobson.
Sale.
Thayer.

Hebrew. (6 Students). Dr. Bloomfield. Twice weekly, Tuesday and Thursday, 3 P. M.

Atkinson.
Cole.
Ingle.
McDaniel.
Prescott.
Spieker.

German. (39 Students). Mr. Brandt.

Classes meet in Rooms 4 and 5, 193 North Eutaw Street.

Advanced Courses: (Four classes), *Gothic*, Ulfila; *Middle High German*, Walther von der Vogelweide, Reichel's Lesebuch; *Deutsche Stilübungen.* Tuesday and Thursday, 9 A. M.; Friday, 4 P. M., and alternate Thursdays, 10 A. M. (4).

Ebeling.
Jagemann.
Sieber.
Thayer.

(*Major Course.*)

German Literature: Alternate Saturdays, 10 A. M. (14).

Bayley.
Crisp.
Duffy.
Fels.
Garthe.
Gittings.
Gordon.
Huggins.
Kemp.
Penniman.
Prescott.
Williams.
Wilson, H. V.
Witzenbacher.

Middle High German: Twice weekly, Tuesday and Wednesday, 11 A. M. (11).

Bayley.
Berry.
Crisp.
Duffy.
Fels.
Gittings.
Gordon.
Kemp.
Palmer, A. G.
Penniman.
Stevens.

Goethe: *Faust;* ***Lessing's*** *Dramas:* Twice weekly, Thursday and Friday, 11 A. M. (14).

Bayley.
Bissing.
Crisp.
Duffy.
Fels.
Gittings.
Gordon.
Hamner.
Huggins.
Kemp.
Lodge.
Page.
Palmer, A. G.
Penniman.

Prose Composition: (*Class A.*) Weekly, Monday, 11 A. M. (2).

Bayley.
Bissing.
Crisp.
Duffy.
Fels.
Gittings.
Gordon.
Huggins.
Kemp.
Palmer, A. G.
Penniman.
Stevens.

(*Minor Course.*)

Schiller: *Prosa:* Twice weekly, Tuesday and Wednesday, 12 M. (9).

Carey.
Cole.
Cromwell.
Crum.
Dorsey.
Hinkley.
Kimball.
Orndorff.
Perkins, C. A.

Goethe: *Prosa:* Twice weekly, Thursday and Friday, 12 M. (12).

Barnes.
Carey.
Cole.
Cromwell.
Crum.
Dorsey.
Hinkley.
Kimball.
Ramage.
Orndorff.
Perkins, C. A.
Thomas.

Prose Composition: (*Class B.*) Weekly, Monday, 12 M. (13).

Carey.
Cole.
Cromwell.
Crum.
Dorsey.
Glenn, J.
Hinkley.
Kimball.
Lodge.
Orndorff.
Ramage.
Stratton.
Thomas.

Romance Languages. (22 Students.)

Classes meet in Rooms B and C, 113 West Monument Street.

Advanced Courses: (4 classes) *Provençal; Wallachian; Old French* [Seminary]; *Romance Dialects:* Mr. Elliott. Daily, Monday, Thursday, and Friday, 1 P. M.; Tuesday, 11 A. M.; Wednesday, 12 M. (4).

Gordon.
Jagemann.
O'Connor.
Taylor.

Spanish: *Don Quijote:* Mr. Elliott. Weekly, Tuesday, 12 M. (7).

Crisp.
Garthe.
Gordon.
Harrison.
Jagemann.
O'Connor.
Wilson, H. V.

Old French: *Aucassin et Nicolete;* ***French Phonetics:*** Mr. Elliott. Twice weekly, Monday and Wednesday, 12 M. (7).

Crisp.
Garthe.
Gordon.
Harrison.
Jagemann.
Taylor.
Wilson, H. V.

Old French Syntax, etc.: Mr. Elliott. Twice weekly, Thursday and Friday, 12 M. (8).

Crisp.
Garthe.
Gordon.
Harrison.
Jagemann.
O'Connor.
Taylor.
Wilson, H. V.

This course includes the study of the so-called Irregular Verb-System of the Romance Languages.

French: *Minor Course:* Mr. Marcou. Daily, 1 P. M. (14).

Bayley.
Campbell.
Friedenwald.
Gittings.
Guard.
Hamner.
Harlan.
Kimball.
Liebig, R. A.
Orndorff.
Palmer, A. G.
Rotch.
Stratton.
Walz.

English. Dr. Wood. (19 Students).

Classes meet in 187 N. Howard Street.

Anglo-Saxon and Early English: (Two classes). Review of Anglo-Saxon Literature; Wülcker's *Altenglisches Lesebuch; Beowulf.* Monday and Friday, 10 A. M.; Wednesday and Saturday, 12 M. (3).

Bright.
Jagemann.
MacClintock, W. D.

This class will later take up Grein's *Bibliothek der Angelsächsischen Poesie.*

Early English: Chaucer: *Prologue, etc.* Four times weekly, Monday, Tuesday, Wednesday, and Thursday, 8 P. M. (6).

Crisp.
Crum.
Garthe.
Lord, J. W.
Stevens.
Stickney.

Early English: *Selections.* Twice weekly, Monday and Wednesday, 2 P. M. (2).

Fels.
Ramage.

English Style: Milton, *Areopagitica, etc.* Weekly, Friday, 8 P. M. (16).

Bemis.
Crisp.
Cromwell.
Crum.
Dorsey.
Duffy.
Fels.
Garthe.
Lord, J. D.
Lord, J. W.
MacClintock, W. D.
Penniman.
Ramage.
Stevens.
Stickney.
Wilhelm.

istory and Political Economy. (80 Students.)

Italian History: DR. ADAMS. Weekly, Saturday, 12 M., Peabody Institute. (7).

Bemis.
Gould.
Jameson.
Johnson, O. A.
Ramage.
Shaw.
Wilhelm.

Institutional History: DR. ADAMS. Weekly, Friday, 8 P. M., Room A, 118 West Monument Street. (18.)

Adkins.
Bemis.
Bowdoin.
Brinton.
Ebeling.
Fels.
Goodman.
Gould.
Ingle.
Jameson.
Johnson, J.
Johnson, O. A.
Linthicum.
Murray.
Ramage.
Shaw.
Sollers.
Wilhelm.

International Law: DR. ADAMS. Daily, 4 P. M., Room A, 118 West Monument Street. (15).

Canfield.
Carey.
Crisp.
Cromwell.
Dorsey.
Duffy.
Gould.
Hamner.
Hinkley.
Johnson,
Penniman.
Reese.
Shaw.
Stickney.
Williams.

Political Economy: DR. ELY. Twice weekly, Monday 12 M.; Thursday, 11 A. M., 198 N. Eutaw Street. (7).

Bemis,
Gould,
Jameson.
Johnson, O. A.
Ramage,
Shaw,
Wilhelm,

Logic, Ethics, &c. (14 Students).

Advanced Course: MR. PEIRCE. Twice weekly, Monday, 8 P. M.; Thursday, 8 P. M., Room B, 118 W. Monument Street. (5).

Gilman.
Ladd.
Mitchell.
Preston.
Swift.

Elementary Course: MR. PEIRCE. Thrice weekly, Tuesday and Friday, 9 A. M.; Wednesday, 10 A. M., Room B, 118 W. Monument Street. (5).

Bissing.
MacClintock, C. T.
Mitchell.
Preston.
Swift.

Logic of Relatives: MR. C. S. PEIRCE. A short course to begin during March.

Ethics: MR. B. E. SMITH. Daily, 1 P. M., Room 8, 198 North Eutaw Street. (8).

Fels.
Gregg.
Ingle.
Leftwich.
MacClintock, C. T.
McDaniel.
Prescott.
Robinson.

History of Philosophy: MR. B. E. Smith. To begin early in April.

Elocution. (27 Students.) MR. WOODWORTH.

Bemis.
Berry.
Carey.
Cromwell.
Davis.
Dorsey.
Duffy.
Fels.
Glenn, J.
Glenn, W. L.
Guard.
Hamner.
Hinkley.
Hobson.
Ingle.
Keiser,
Leftwich.
Lord, J. D.
Lord, J. W.
Miller, E. G.
O'Connor.
Penniman.
Perkins, C. A.
Ramage.
Rotch.
Stokes, G. C.
Wilhelm.

Drawing. (21 Students).

MR. NEWELL. Twice weekly, Tuesday and Friday, 2.30 P. M., Room 1, 198 North Eutaw Street.

Campbell.
Canfield.
Colton.
Conn.
Davis.
Day, D. T.
Friedenwald.
Kemp.
Lee,
Liebig, G. A.
Liebig, R. A.
Lord, J. W.
Osborn.
Page.
Reese.
Sewall.
Stokes, G. C.
Stratton.
Thomas.
Wiegand.
Wilson, H. V.

COMMEMORATION DAY.

The twenty-second day of February, 1882, was observed according to age as the Commemoration Day of the University. The public exer- ses of the day were held in Hopkins Hall at four o'clock in the afternoon. brief address was made by President Gilman, after which Professor D. Morris presented the candidates for the Baccalaureate degree as llows:

William H. Adkins, of Easton, Md., who received his previous training the Easton (Md.) Classical School, and has finished major courses in istory and Latin, and minor courses in German, Greek, and Physics.

Hermann L. Ebeling, of Catonsville, Md., who pursued his preliminary dies at Overlea School, Catonsville, and has completed major courses German and History, and minor courses in Greek, Latin, and Physics.

Edward Ingle, of Baltimore, a former student of the City College, who s followed major courses in Greek and Latin, and minor courses in erman, History, and Physics.

With the assent of the Trustees, these matriculated students were then vanced to the degree of Bachelor of Arts.

Public announcement was made that the degree of Doctor of Philosophy d been conferred on Mitsuru Kuhara (S. B., University of Tokio, 1877), ovember 7, 1881; and in this connection, Professor Remsen gave an count of Dr. Kuhara's work while here.

On the previous evening, from 8 to 11, there was a social assembly of e officers and students, and their friends. The library and halls of the niversity were thrown open to a company of gentlemen and ladies, veral hundred in number.

A course of free lectures, specially designed for the employees of the ltimore and Ohio Railroad Company, was delivered in Hollins Hall, ltimore, during February, by PROFESSOR MARTIN, and DRS. BROOKS, WALL, and SEDGWICK.

RECEPTION IN HONOR OF PROFESSOR CAYLEY.

On Friday evening, February 8, the Trustees of the University gave a reception in Hopkins Hall in honor of Professor Cayley, Sadlerian Professor of Pure Mathematics in the University of Cambridge, who is lecturing here during the current session. A large number of gentlemen and ladies from Baltimore, Washington, and other cities were present. Brief addresses were made by Hon. George William Brown and Professor Sylvester.

GRADUATE SCHOLARSHIPS.

The Trustees have appointed, upon the recommendation of the Academic Council, the persons below named to Graduate Scholarships for the current year.

Buel P. Colton (*A. B., Amherst*, 1874).
Ellery W. Davis (*S. B., University of Wisconsin*, 1879).
William S. Fleming (*A. B., Davidson College*, 1878).
William H. Howell (*A. B., Johns Hopkins*, 1881).
William D. MacClintock (*A. B., Kentucky Wesleyan*, 1878).
Chalmers C. Norwood (*A. B., Davidson*, 1878).
William A. Noyes (*A. B., Iowa*, 1879).
Charles A. Perkins (*A. B., Williams*, 1879).
William C. Thayer (*A. B., Columbia*, 1876).
Lewis W. Wilhelm (*A. B., Johns Hopkins*, 1880).

A course of lectures by members of the University have been in progress during the winter, at the McDonogh School. The course includes lectures by Messrs. Martin, Remsen, Scott, Hastings, Wood, and Elliott.

HOURS FOR LECTURES AND RECITATIONS, SECOND HALF-YEAR, 1881-82.

HOURS.	MONDAY.	TUESDAY.	WEDNESDAY.	THURSDAY.	FRIDAY.	SATURDAY.
A. M. 9	General Chemistry. (Morse.) Sophocles. (C. D. Morris.) Latin Prose. (Nicolassen.) Solid Anal. Geom.: Adv. (Story.) Organic Chemistry. (Remsen.)	General Chemistry. (Morse.) Greek Prose. (C. D. Morris.) Horace. (Nicolassen.) Logic: Elem. (Peirce.) Mammal. Anatomy. (Brooks.) Middle High German. (Brandt.) Part. Diff. Equa. (Craig.) Organic Chemistry. (Remsen.)	General Chemistry. (Morse.) Sophocles. (C. D. Morris.) Horace. (Nicolassen.) Physics: Major. Laboratory work, 9 a. m. to 5 p. m. (Hastings.) Organic Chemistry. (Remsen.)	General Chemistry. (Morse.) Sophocles. (C. D. Morris.) Horace. (Nicolassen.) Mammal. Anatomy. (Brooks.) Gothic. (Brandt.) Solid Anal. Geom.: Adv. (Story.) Organic Chemistry. (Remsen.)	General Chemistry. (Coale.) Sophocles. (C. D. Morris.) Horace (Nicolassen.) Logic: Elem. (Peirce.) Solid Anal. Geom.: Adv. (Story.)	
10	Physics. (Hastings.) Juvenal, etc. (C. D. Morris.) Physiology: Elem. (Sewall.) Modern Algebra. (Franklin.) Anglo-Saxon: Adv. (Wood.)	Physics. (Hastings.) Plato: Readings. (Gildersleeve.) Latin Prose. (C. D. Morris.) Physiology: Elem. (Sewall.) Quaternions. (Story.) Theory of Equations. (Franklin.)	Physics. (Hastings.) Juvenal, etc. (C. D. Morris.) Physiology: Elem. (Martin.) Quaternions. (Story.) Theory of Equations. (Franklin.) Logic: Elem. (Peirce.)	Physics. (Hastings.) Juvenal, etc. (C. D. Morris.) Physiology: Adv. (Martin.) Mineralogy. (Morse.) Modern Algebra. (Franklin). Deutsche Stilübungen. (Brandt.) (Alternate Thursdays)	Physics. (Hastings.) Greek Philosophy. (Gildersleeve.) Juvenal, etc. (C. D. Morris) Physiology: Elem. (Sewall.) Quaternions. (Story.) Mineralogy. (Morse.) Theory of Equations. (Franklin.) Anglo-Saxon: Adv. (Wood.)	German Literature. (Brandt.) (Alternate Saturdays.)
11	Physiology: Adv. (Martin.) German: Major. (Brandt.) Terence, etc. (Warren.) Greek Prose. (Nicolassen.) Part. Diff. Equa. (Craig.) Osteology. (Brooks.)	German: Major. (Brandt.) Latin Prose. (Warren.) Homer. (Nicolassen.) Elasticity. (Craig.) Integral Calculus. (Franklin.) Romance Lang.: Adv. (Elliott).	General Biology. (Sedgwick.) German: Major. (Brandt.) Terence, etc. (Warren.) Homer. (Nicolassen.) Elasticity. (Craig.) Integral Calculus. (Franklin.)	General Biology. (Sedgwick.) German: Major (Brandt.) Terence, etc. (Warren.) Homer. (Nicolassen.) Part. Diff. Equa. (Craig.) Osteology. (Brooks.) Political Economy. (Ely.)	General Biology. (Sedgwick.) German: Major (Brandt.) Terence, etc. (Warren.) Homer. (Nicolassen.) Elasticity. (Craig) Integral Calculus. (Franklin)	Metres. (C. D. Morris.)
M. 12	Plato: Lect. (Gildersleeve.) German: Minor. (Brandt.) Heat Conduction. (Rowland.) French: Major. (Elliott.) Political Economy. (Ely.)	German: Minor. (Brandt.) Heat Conduction. (Rowland.) French: Major. (Elliott.) Greek History. (C. D. Morris.)	Plato: Seminary. (Gildersleeve.) German: Minor. (Brandt.) Heat Conduction. (Rowland.) French: Major. (Elliott.) Anglo-Saxon: Adv. (Wood.) Romance Lang.: Adv. (Elliott.)	Greek Lit. (Gildersleeve.) German: Minor. (Brandt.) French: Major. (Elliott.)	German: Minor. (Brandt.) Heat Conduction. (Rowland.) French: Major. (Elliott.) Thermo-Chemistry. (Remsen.)	History: Adv. (Adams.) Anglo-Saxon: Adv. (Wood)
P. M. 1	French: Minor. (Marcou.) Higher Pl. Curves: Elem. (Story.) Elliptic Functions. (Craig.) Philosophy: Minor. (Smith.) Romance Lang.: Adv. (Elliott.)	French: Minor. (Marcou.) Philosophy: Minor. (Smith.)	French: Minor. (Marcou.) Higher Pl. Curves: Elem. (Story.) Elliptic Functions. (Craig.) Philosophy: Minor. (Smith.)	French: Minor. (Marcou.) Higher Pl. Curves: Elem. (Story.) Elliptic Functions. (Craig.) Philosophy: Minor. (Smith.) Romance Lang.: Adv. (Elliott)	French: Minor. (Marcou.) Philosophy: Minor. (Smith.) Romance Lang.: Adv. (Elliott.)	
2	Early English. (Wood.) Drawing. (Newell.) (2.30 p. m.)		Early English. (Wood.)		Drawing. (Newell.) (2.30 p. m.)	
3	Chaucer. (Wood.) Sanskrit: Elem. (Bloomfield.)	Chaucer. (Wood.) Hebrew. (Bloomfield.)	Chaucer. (Wood.)	Chaucer. (Wood.) Hebrew. (Bloomfield.) Physics: Major. (Hastings.) Logic: Adv. (Peirce.)	English Style. (Wood.) Sanskrit: Elem. (Bloomfield.)	
4	History: Minor. (Adams.) Alg. Geometry. (Cayley.) Sanskrit: Adv. (Bloomfield.)	History: Minor. (Adams.) Vergil: Seminary. (Warren.) Multiple Algebra. (Sylvester.) Sanskrit: Adv. (Bloomfield.)	History: Minor. (Adams.) Compar. Philol. (Bloomfield.)	History: Minor. (Adams.) Latin Inscriptions. (Warren.) Alg. Geometry. (Cayley.) Sanskrit: Adv. (Bloomfield.)	History: Minor. (Adams.) Vergil: Seminary. (Warren.) Multiple Algebra. (Sylvester.) Sanskrit: Adv. (Bloomfield.) Middle High German. (Brandt.)	
5	Logic: Adv. (Peirce.) (8 p. m.)		Sanskrit: Elem: (Bloomfield.)		Institut. Hist. (Adams.) (8 p. m.)	

GENERAL STATEMENTS.

ADMISSION OF STUDENTS.

Arrangements are made for the reception of the following classes of students:

I. *Graduates.*

Young men who have already graduated in institutions of acknowledged standing are received, without formal examination, on the presentation of their diplomas, after satisfying the chief instructors in the departments of study which they propose to follow that they are qualified to pursue the courses here given. They may be enrolled as candidates for the degree of Doctor of Philosophy or not, at their option. Those whose years and attainments correspond with those of graduates may also be received as special university students.

II. *Collegiate Students.*

Young men who desire a liberal collegiate training, as the foundation for their future professional life, are expected to matriculate, by passing a formal examination, and entering upon a course of study which leads to the degree of Bachelor of Arts. It is desirable that they should pass this examination thoroughly at the time of their admission. If they present themselves with higher attainments than those requisite for matriculation, they may, upon examination, receive credit for the same, be admitted to advanced classes and so graduate in less time than would otherwise be requisite.

III. *Non-Matriculates.*

1. STUDENTS IN SUBJECTS PRELIMINARY TO A MEDICAL COURSE.—A course of studies, including Physics, Chemistry, and Biology, with German, French, English, Psychology, and Ethics, has been arranged for the instruction of young men who intend at a later day to pursue the study of medicine. Those who are not candidates for the degree of Bachelor of Arts may be admitted to this course on passing a prescribed examination as elsewhere stated (see p. 198). If, after entering the University, they desire to become candidates for this degree, they will be encouraged to pass the usual matriculation examination.

2. SPECIAL STUDENTS.—Young men of collegiate age, who can satisfy a committee consisting of the President and two of the chief instructors that they are sufficiently advanced in character and attainments to be allowed the privilege, and that there is some good reason why they should not offer themselves for matriculation, may be admitted to certain classes; but this privilege may be forfeited at any time, if the student is found unworthy of it.

3. ATTENDANTS UPON LECTURES.—The University has extended certain privileges to teachers following special courses arranged for them, to medical students attending demonstrations in Physiology, and to other persons admitted to the lectures in Hopkins Hall, but they are not regarded as belonging to the University and are not enumerated as enrolled students.

TIME OF ADMISSION.

The proper time for entrance is at the beginning of the academic year, when there are formal appointed examinations.

The examinations for matriculation in 1882 will be held from Monday, June 5 to Thursday, June 8, and from Wednesday, September 20 to Saturday, September 23.

Informal preliminary examinations may be held from time to t [illegible] mutual agreement between the President and the candidat [illegible] or the purpose of ascertaining whether a student should be encouraged to present himself for the matriculation examination, and of giving him counsel as to the progress of his studies. To persons at a distance, blank forms of application will be forwarded, upon the return of which, properly filled out, the candidates will be advised as to the expediency of their coming to Baltimore.

CHARGES FOR TUITION, etc.

The charge for tuition is eighty dolllars per year payable in two sums, forty dollars on the first of October, for the first half year, and forty dollars on the first of February, for the second half year. The Treasurer's office is not authorized to make a deduction for a period less than half a year, or to make a deduction because the student gives only a part of his time to study, or because he belongs to but one class. A deposit of ten dollars is required from each student.

Charges for materials, instruments, etc., are made in the laboratories.

Those who merely attend the annual course of Chemical lectures and have no other connection with the University will pay the sum of twenty dollars.

Those who merely attend the annual course of Biological lectures and have no other connection with the University, will pay for this privilege the sum of twenty dollars.

To medical men, graduate students, and others taking only the annual course of instruction in Animal Physiology, with the corresponding laboratory practice, a charge of fifty dollars is made, which includes payment for material and the use of apparatus.

Board and lodging in private houses near the University, including care of room, fuel, and light, may be obtained at five or six dollars, and upwards per week.

CALENDAR.

The present term will close on Friday, June 9, 1882.

Examinations for matriculation will be held as above stated.

The next term will begin Tuesday, September 19. The first week of the term is devoted to the examination of candidates for admission and matriculation and to the organization of classes.

Instructions will be resumed Tuesday, September 26, 1882.

UNIVERSITY INSTRUCTION.

Advanced and graduate students are received with or without reference to their being candidates for a degree, and they are permitted to attend such lectures and exercises as they may individually select.

The University professors are not absorbed in the details of college routine, but are free to give personal counsel and instruction to those who seek it; books and instruments adapted to investigation and advanced work have been liberally provided; the system of Fellowships secures the presence of twenty special students, imbued with the University spirit, most of them looking forward to academic careers; seminaries limited to a few advanced students, under the guidance of a director, have been organized in Greek, Mathematics, etc.; societies devoted to Philology, to Mathematical, Physical, and Natural Science, to Metaphysics, and to History and Political Science, afford opportunities for the presentation of memoirs and original communications, and there are also clubs for the reading and discussion of Biological, Physical, and Chemical journals; during the year, courses of lectures are given by resident and non-resident professors on topics to which they have given special attention; the libraries of the Peabody Institute and Maryland Historical Society, founded for the advantage of scholars, are easily accessible; the issuing, under the auspices of the Trustees, of publications devoted to Mathematics, Chemistry, Philology, and Biology brings the University into advantageous connexion with other scientific foundations; and the University reading-room, which is constantly open, is liberally supplied with new and with standard books and with the literary and scientific journals of this and other lands.

The instruction is carried on by such methods (varying of course with individual scholars, and with the different departments of work) as will encourage the student to become an independent and original investigator, while he is growing more and more familiar with the work now in progress elsewhere, and with the results which have been obtained by other scholars in the same field, and while he is adding to his general intellectual culture. Within reasonable limits, the University will provide such books, apparatus, and material as may be requisite for this purpose.

The instruction for graduate students varies somewhat each year in its details, which may be ascertained by correspondence or by consulting the programmes and announcements published in the summer.

Courses may always be expected in the following subjects:

Mathematics,
Physics,
Chemistry,
Biology,
Logic,
Philosophy,
History,
Political Economy,
Comparative Philology,
Sanskrit,
Greek,
Latin,
Romance Languages,
Teutonic Languages,
English.

The Degree of Master of Arts and Doctor of Philosophy will be conferred on graduate students in conformity with the regulations laid down, a statement of which may be obtained on application.

Fellowships.

Twenty Fellowships are annually open to competition in this University, each yielding five hundred dollars and exempting the holder from all charges for tuition. *Applications for the next year must be received before May 12, 1882.*

Graduate Scholarships.

Ten graduate scholarships, each yielding two hundred and fifty dollars in addition to tuition, have been awarded during the current year to students, who gave special evidence of exceptional merit in the prosecution of their studies. Further announcements may be looked for in the Register.

COLLEGE COURSES.

Collegiate instruction is provided for undergraduate students, especially for young men from Baltimore and its vicinity.

Some peculiar features of the methods pursued here may be worth notice. The large number of instructors in proportion to that of the scholars gives the latter the advantage of close personal observation and guidance. The traditional division of undergraduate students into four classes is not adopted here, and in consequence the rate of the progress of one is not regulated by that of another. A student who possesses superior advantages as regards health, talent, diligence, early training, etc., can avail himself of them in rapidly attaining his degree; while another who labors under corresponding disadvantages may take a longer time without any loss of self-respect. Students are permitted to make under the guidance of the University a selection of studies in accordance with their special needs; and thus some receive the ordinary college training in classical studies, while with others attention is chiefly directed to modern scientific methods; but there is no marked separation between those who follow the old paths and those who choose the new. The same standard of matriculation is established, the same firmness and persistence of application are expected, the same severity of examinations is maintained for all classes of students, and care is taken that every one who receives the Baccalaureate degree shall be liberally trained in languages, mathematics, or some branch of science, the proportion of different studies being left to the choice of the student under the regulation of the Faculty.

Requirements for Matriculation.

The special requirements for matriculation are as follows:

The subjects named, in both Mathematics and Languages, merely indicate the range of the examination. Equivalents are accepted.

The accurate reading at sight of passages previously unseen may render unnecessary the examination in the books specified.

Latin. Grammar, Prosody and Composition; *Cæsar*, 5 books; *Ovid*, 2500 verses (500 elegiac); *Virgil*, Æneid, 6 books, and Eclogues; *Cicero*, 7 orations; *Livy*, 1 book; *Horace*, Odes, 2 books.

Greek. Grammar, Prosody, and Composition; *Xenophon*, Anabasis, 4 books; *Homer*, Iliad, 4 books; *Herodotus*, 1 book; any one drama.

Mathematics. *Arithmetic*, including the Metric System; *Algebra*, Todhunter, 38 chapters; *Geometry, Plane and Solid*, Chauvenet; *Plane Trigonometry*, Chauvenet, 8 chapters; *Analytic Geometry*, Straight Line and Circle in rectangular coördinates, Salmon (Conic Sections) or Howison.

The examinations in Algebra and Geometry must be passed before the candidate will be examined in Trigonometry and Analytic Geometry.

Candidates who do not intend to pursue a classical course may offer German and French instead of Greek. The equivalent of a minor course in one of these subjects will be expected, and a good elementary knowledge of the other.

SPECIAL EXAMINATION IN ENGLISH.—All candidates for admission will be expected to satisfy the authorities that, in addition to the studies in Mathematics and Languages required for admission, they have been well trained in the ordinary English branches, including the use of the English language, Geography, and United States History.

SPECIAL EXAMINATION IN NATURAL SCIENCE.—Each candidate for admission is expected to offer for examination in some branch of Natural Science. Physical Geography is recommended as within the reach of all. An elementary acquaintance with Botany, Zoölogy, or Natural Philosophy is also desirable.

Courses of Study.

Courses of study are arranged for collegiate students in Mathematics, Physics, Chemistry, and Biology; in Greek, Latin, French, German, and English; and in History, Political Economy, etc. It is not supposed that any student can follow all these courses, but every one is required to select such a combination as will secure to him a liberal education, founded upon studies in several branches of literature and science. As a rule, each student will have three courses in progress simultaneously with five weekly exercises in each.

The following combinations are suggested (but not prescribed exclusively) as an aid to students in the selection of their courses for the Bachelor's Degree:

1. CLASSICAL, in which Greek and Latin are the main subjects, and a Modern Language, one Philosophical and one Scientific course subordinate; 2. MATHEMATICAL, with Mathematics and Physics as main subjects, and in addition a Modern Language, Chemistry, and one Philosophical course; 3. SCIENTIFIC, in which marked proficiency in Mathematics, and in either Chemistry, Physics, or Biology is required, and in addition one Scientific course, one Philosophical, and one in Language; 4. LITERARY, in which the Romance and Teutonic Languages are taken as the main subjects, and Latin and any other two courses, one of which must be Scientific, as subordinate; 5. PRELIMINARY TO MEDICINE, in which the principal studies are Biology and Chemistry, and in addition Physics, a Modern Language, and one Philosophical course; 6. PRELIMINARY TO THEOLOGY, in which Greek and Hebrew are the principal subjects, and one Philosophical and two Scientific courses subordinate; 7. PRELIMINARY TO LAW, in which marked proficiency in History and Philosophy is required, and in addition a Modern Language and two Scientific courses; 8. PRELIMINARY TO BUSINESS.

Special Course Preliminary to Medicine.

This course is framed to meet the wants of those who intend at a later day to begin the study of Medicine.

The requirements for entrance by non-matriculated students to the course are as follows:

Elementary Mathematics. Arithmetic; Algebra; three books of Euclid, or an equivalent amount of Geometry; Plane Trigonometry, and the use of Logarithms.

The examination in Algebra will be confined to the following: definitions and explanations of algebraical signs and terms; addition, subtraction, multiplication, and division of algebraical quantities; ratio, proportion, variation; simple equations involving not more than two unknown quantities.

Latin. Translation of passages from the first four books of Cæsar, *De Bello Gallico*, and of the sixth book of the Æneid; the elements of Latin Grammar, especially Accidence.

Candidates who obtain permission at least a fortnight previously, will be permitted to offer themselves for examination in equivalent portions of other Latin classics.

English. Candidates will be examined in the whole of Lounsbury's History of the English Language, and will be required to satisfy the examiner, by means of a written composition, of their ability to express themselves in correct and idiomatic English, properly spelled, punctuated, and divided into paragraphs.

Physical Geography. Guyot's Physical Geography and Huxley's Physiography are recommended as text books.

French and German. In addition to the above subjects, candidates may offer themselves for examination in French and German; those who pass will be excused from attendance upon the instruction in those languages during the subsequent course of study.

The examination in French and German will test the candidate's knowledge of the elements of the Grammar of those languages, and his ability to translate at sight easy passages from prose authors.

Drawing. Some knowledge of Drawing is very desirable; students who are proficient in this subject may omit it from the subsequent course.

Those who wish to follow this course should indicate their intention to do so before the examinations for admission begin.

A circular giving the details of the course may be obtained on application.

Scholarships.

A limited number of free scholarships are awarded to young men from Maryland, the District of Columbia, Virginia and North Carolina.

The Register will be issued at the close of the current Academic year, and will give full information as to the plans and work of the University.

Baltimore, March 15, 1882.

THE ENOCH PRATT FREE LIBRARY.

Mr. Enoch Pratt, a merchant of this city, has offered to endow a Free Public Library in Baltimore, on conditions which have been readily and gratefully accepted by the city authorities to whom his letter is addressed.

The gift commands the admiration of all who hear of it, not only for its amount but for the wise plan on which the enterprise is founded. His name will henceforward be remembered among the greatest benefactors of Baltimore.

Mr. Pratt's letter announcing his gift is as follows:

BALTIMORE, *January* 21, 1882.

To the Honorable the Mayor and City Council of Baltimore:

I have for some years contemplated establishing a free circulating library for the benefit of our whole city, and in pursuance of this plan I have entered into a contract to erect a fireproof building on my Mulberry street lot capable of holding two hundred thousand volumes, my purpose being to have branches connected with it in the four quarters of the city, under the same management. The excavation for the foundation has been commenced, and the building will be well advanced this year and completed in the summer of 1888. It will cost, when ready for occupancy, about two hundred and twenty-five thousand dollars, and upon its completion I propose to deed it to the city. The title to all the books and property is to be vested in the city, and I will pay to your honorable body upon its completion the additional sum of eight hundred and thirty-three thousand three hundred and thirty-three and a third dollars, making one million fifty-eight thousand three hundred, thirty-three and one-third dollars, provided the city will grant and create an annuity of fifty thousand dollars per annum forever, payable quarterly, to the board of trustees for the support and maintenance of the library and its branches.

I propose that a board of nine trustees be incorporated for the management of "The Pratt Free Library of the City of Baltimore," the board to be selected by myself from our best citizens, and all vacancies which shall occur shall be filled by the board. The articles of incorporation will contain a provision that no trustee or officer shall be appointed or removed on religious or political grounds. The trustees are to receive from the city the quarterly payments, and to expend it at their discretion for the purposes of the library.

It is believed that this annual sum will afford a sufficient fund for the purchase of books for establishing the branches, and for the general management.

The trustees will be required to make an annual report to the Mayor and City Council of their proceedings and of the condition of the library, and the report will contain a full account of the money received and expended.

This plan is suggested not without due consideration of the power of the city to carry it out. The city is expressly authorized by its charter to accept trusts "for any general corporation purpose" "or for the general purposes of education;" and although its power of creating debts is limited by the constitution of the State, yet as the property of the Library is to belong to the city, and as it will receive a sum of money to be disposed of as it pleases, with the engagement only to pay an annual sum for the support of its own institution, it is believed that such a transaction will not involve the creation of a debt within the meaning of the constitutional prohibition.

I suggest that if the money to be paid by me as above stated were added to the sinking fund and the interest carefully funded it would in no very long time pay off the debt of the city; but this is intended only as a suggestion, and the disposal of the money is left to your honorable body.

If, however, your honorable body should on mature consideration be of the opinion that the annual payments as proposed would involve the creation of a debt, authority for that may be obtained by complying with the provisions of the constitution; that is, the debt may be created by the city, provided it be authorized by an act of the General Assembly of Maryland and by an ordinance of the Mayor and City Council of Baltimore, submitted to the legal voters of the city of Baltimore, at such time and place as may be fixed by said ordinance, and approved by a majority of the votes cast at such time and place. I cannot but think that such an authority from the General Assembly and from the Mayor and City Council of Baltimore and from a majority of the legal voters of the city would be cheerfully given.

The plan proposed for the support and management of the library is the result of long and careful consideration, and, I am satisfied, is well adapted to promote the great object in view, the free circulation of the books of a large and ever-growing library among the people of the whole city.

I trust that it will receive the approval of your honorable body and of the citizens of Baltimore. ENOCH PRATT.

The gentlemen selected by Mr. Pratt as trustees to manage the affairs of the Library are: Enoch Pratt, Hon. George Wm. Brown, Nathaniel H. Morison, Henry Janes, Charles J. Bonaparte, George B. Cole, Edward Stabler, Jr., James A. Gary and John W. McCoy.

Libraries in Baltimore.

In this connection the following article on the Libraries of Baltimore in the issue of *The Nation*, New York, February 9, 1882, will be of interest:

The gift of over a million dollars to the city of Baltimore for the establishment of a free circulating library upon municipal foundations suggests a review of Baltimore libraries in general. Before the announcement of Mr. Pratt's gift, free lending libraries on a small scale and of a secular character were already in existence. Three years ago, in a night-school for boys which was started at a mission-station of Grace Church, a circulating library began to develop, as it were, by spontaneous generation. In the first place, a lad asked the Superintendent if he might take a certain book home. This was irregular, but a patron of the school ventured to assume the responsibility. The demand for books naturally increased, and at first the gentleman endeavored to meet it by allowing boys to take books from his private library. These naturally went the rounds, and fresh contributions were obtained from friends of the school. A library was organized with a nucleus of fifteen books. The first year it increased to 250 volumes, the second year to 1,000, when the collection was legally incorporated as "The Baltimore Free Circulating Library." During the year it grew to 1,400 volumes, which are now distributed at library stations in four quarters of the city.

Books are sent out from the original centre in small lots of 200 or more, and when they have been read at one place they are removed to another and a fresh supply is substituted. Thus the whole library circulates. During the past year this collection of 1,400 books, administered at the incredibly small expense of $135, has been drawn upon 4,506 times. Considering that the station-libraries are open only once or twice a week, and in no case for more than seven months in the year (in one case for only two) this is very remarkable. But more extraordinary is the fact that the loss of books has been less than one per cent. At the station in East Baltimore not a book has been lost. In this quarter boys have clubbed together under the authority of a librarian, one of their number, who rules his tribe with almost absolute power. The boys pay taxes of two or three cents a week for the purchase of fuel, so as to keep open their reading-room every evening from seven until ten o'clock. This room was rented on the ground floor of a private house, and is a cheery place, with its good fire and tables spread with illustrated newspapers, magazines, and checker-boards. Anybody can have free access to the conveniences of this "Club," provided his moral character is endorsed by a member, or a policeman, or any person of established reputation. Another interesting branch of the Baltimore Free Circulating Library has been instituted in the new mission-house of the Society of Friends, in the vicinity of Federal Hill, which was the site of Butler's battery commanding Baltimore in war-time, but which is now in process of transformation from an unsightly clay-bank into a sightly terrace, affording a fine view of the city and harbor.

Still another free library, although quite independent of the above group, has been in successful operation for the past two or three years at Canton, among the rolling-mills and oil works. This library is open not only week days but also on Sundays, and that, too, by the special request of the clergymen of the neighborhood. The reading-room is well-supplied with magazines and newspapers. The whole enterprise is in connection with the Workingmen's Institute of Canton, which comprises lectures by instructors from the Johns Hopkins University, public readings, concerts, and the like. The employees of the Baltimore and Ohio Railroad have also their free lending library and a course of free lectures by teachers of biology from the University. At the first lecture, which was upon the suggestive topic "How Skulls and Backbones are Made," President Garrett reminded the audience that Johns Hopkins left all that portion of his estate which was invested in the stock of the Baltimore and Ohio Railroad to the University that bears his name, and that the earnings from that stock, were, therefore, its chief support. He said it had occurred to the president of the road that its employees and their families might secure some of the benefits to be derived from that University, and he had accordingly spoken to some of the professors, who had consented to give a few instructive lectures. Thus the workingmen of the laboratory and machine-shop are brought together. It is wonderful to observe the interest of manufacturing districts in libraries and reading-rooms. Woodberry has just organized such an associate institution, in which all classes and sects, Protestants and Catholics, are happily united. Catonsville, a place of less than 2,000 inhabitants, has maintained for several years a similar association, encouraging not only reading but also music, the drama, and the playing of billiards in a reputable place. It is noteworthy that the establishment of the Catonsville Library as "a general meeting-place for citizens," has lately resulted in a memorial to the Legislature for the incorporation of this village into a town by itself. The importance of schools and library associations, as germs of corporate life, and as points of cohesion for church sects, is gradually becoming apparent.

On the first of January, 1882, the Mercantile Library Association, which was first started in 1839 by a few clerks and business men, opened its doors to the public in a new building, erected as headquarters for the trustees of the Wilson Sanitarium (another monument of Baltimore private philanthropy—for securing, in summer, country and sea air for sick people too poor to leave the city). The Wilson building, the upper part of which is devoted to offices, is situated upon a convenient corner, and fronts fashionable Charles Street. Baltimoreans passing this fine new building on New Year's Day could look in from the sidewalk upon a most inviting scene. Naturally everybody entered to attend the reception given by the president and librarian of an old Baltimore association, now rescued from its basement quarters and side-hill tendencies, and firmly established in a convenient, well lighted, highly attractive place. The spacious rooms, their comfortable and even elegant appearance, the evidently increased supply of new books, papers, and magazines, the perfect ease and freedom of access to the shelves—these things, combined with the well-known fact that the president of the Association had made the transfer at his own expense, and had guaranteed the rental of the building for five years, revolutionized the Mercantile Library in a day. The membership began to increase, old members returned, everybody determined to pay his subscription, and it is now confidently believed that the Mercantile will once more become self-supporting, notwithstanding the immediate prospect of a Free Circulating Library for all Baltimore. A certain class of people will prefer, on some accounts, a library which is not so free and not so public; and the Charles Street corner has many attractions.

Three weeks after the New Year's opening of the Mercantile came the letter of Enoch Pratt to the Mayor and City Council of Baltimore announcing his proposition to erect upon his Mulberry Street lot (valued at $30,000) a fire-proof library building, capable of holding 200,000 volumes, and costing, "when ready for occupancy," in the summer of 1883, about $225,000. This entire property, embracing grounds and building, Mr. Pratt proposed to deed to the city, and then to pay over the sum of $833,333.33⅓, making a total gift equivalent to $1,058,333.33⅓. The only condition which Mr. Pratt attached to this magnificent donation was that the city should make the Library a municipal institution, by creating an annuity of $50,000 forever, payable quarterly to a close corporation of trustees, for the future maintenance of the Library in its various branches. The point of the whole matter is not generally understood. The Library, according to Mr. Pratt's idea, is to be, not privately endowed, but a public institution, supported by public moneys. He gives outright to the city of Baltimore the sum of $833,333.33⅓, and suggests that it be added to the sinking fund for the gradual payment of the city debt. Of course, if applied to library purposes, the income of the money donation, at the rate of six per cent., would yield the precise amount of the required annuity, although at present rates there would probably be a deficiency which the city would have to make up by self-taxation. But that is not the point. The city of Baltimore can apply the interest or principal of this donation to any public purpose whatever, and it may even lose the whole amount by bad investments, but will remain bound forever to pay an annuity of $50,000 to support its Free Public Library, for, by an act of the City Council, on the 31st of January, signed by the Mayor, February 3, the terms of Mr. Pratt's generous and far-sighted offer were formally accepted. In token of public appreciation of private munificence, the municipal government recommends that the trustees, whom Mr. Pratt is to appoint, organize under the name of "The Enoch Pratt Free Library of Baltimore City."

Workmen are now preparing the ground for the new building, the details of which were planned by an architect under the personal direction of the Provost of the Peabody Institute, who has been Mr. Pratt's chief adviser in this regard. The Provost, in an article explaining to the Baltimore public the plans of the new library—an article published at the same time as Mr. Pratt's letter—says:

> "Baltimore has long needed a popular library to supplement her noble scholar's library in the Peabody Institute. That collection of books will supply students with all they require in their difficult and recondite pursuits, but in no sense can it supply the want of the great mass of the people. The great want of books at home, which the Peabody Library, as a reference library, cannot possibly meet, will now be supplied by the munificent endowment of Mr. Pratt. These two libraries will form a complete library system, each supplementing the other; each supplying a want that the other does not reach. And there will be no rivalry between them, unless it be a generous rivalry for excellence, each in its own sphere of usefulness. One is intended for scholars, the other for the people. One is designed to promote the highest culture of the learned few, the other to increase the knowledge and intelligence of the busy many."

No individual benefaction is altogether independent of public or private influences and of historical environment. Broad schemes of philanthropy like that of John McDonogh, who left $1,400,000 to the cities of Baltimore and New Orleans for the education of poor boys; that of George Peabody, who left $1,250,000 for the founding of the Peabody Institute in Baltimore; that of Johns Hopkins, who left $7,000,000, one half for a hospital, the other half for a university—such philanthropy is the product not alone of broad minds, but of broad experience in the world and of wise association with suggestive men; of a careful study of existing institutions, and of a keen discernment of the spirit of the times. It would be interesting if Mr. Pratt should ever describe the formative process of his own great plan, which originated ten years ago, but which has grown by conference with friends and by observation of existing libraries, even of the Mercantile Association, and of those small branches of the first "Baltimore Free Circulating Library." Mr. Pratt has been one of the trustees of the Peabody Institute from its very foundation. His legal adviser, who drew the will in which Mr. Pratt's idea was first outlined, was a member of the same board. No one realized more fully than did these men that the Peabody plan did not embrace the idea of a popular lending library. In a letter to the original board of Peabody trustees, the founder of the Institute provided for "an extensive library, to be well furnished in every department of knowledge—to be maintained for the free use of all persons who may desire to consult it—to satisfy the researches of students who may be engaged in the pursuit of knowledge not ordinarily attainable in the private libraries of the country." He distinctly recommended "that it shall not be constructed upon the plan of a circulating library; and that the books shall not be allowed to be taken out of the building, except in very special cases, and in accordance with rules adapted to them as exceptional privileges." Evidently Mr. Peabody's idea was to establish a library for scholarly research, something like the British Museum. Other provisions for his Institute show that he was aiming to engraft upon Baltimore the offshoots of the highest culture attainable in the great capitals of Europe. He instituted "lectures by the most capable and accomplished scholars and men of science." He planned for a Conservatory of Music, a Gallery of Art, and an annual exhibition of paintings. He established a system of prizes, not for common schools, but for high schools. He aimed at the higher education, and meant to elevate the masses, not by descending to their standards, but by raising theirs to his. And the far-sighted wisdom of the Peabody foundation is now evident in many ways, in a growing interest in libraries and good books, in the development of the "high school" idea into a university, in a wonderful popular interest in scientific lectures, in classical music, and art in general. Nothing proves so well the power of high ideas as their influence in creating a demand for higher things. The Peabody Institute and the Johns Hopkins University make their influence felt in the mechanic's workshop as well as in schools and libraries.

It is impossible in a few words to give any adequate conception of the present resources and growing wealth of the Peabody Library. That collection for scholarly research was begun in 1861, and now embraces 73,000 volumes of a strictly scientific character. Popular works, ephemeral literature, and "the latest novel" have been rigorously excluded. The trustees of the Peabody Institute, who are among the most respected, influential, and cultivated men in Baltimore, have held firmly to the Peabody idea of securing the highest and the best. "Quietly, without pause, without parade, amid much ignorant cavilling and vituperation, they have pursued their work of collecting a library which should furnish the student the best books in all languages, and in all departments of human knowledge." The collection was begun through the aid of specialists in various parts of the country, who recommended books, many of which were purchased by European agents. Professors at Harvard, Yale, Brown, Virginia, and Michigan Universities, lecturers at the Peabody Institute, scientific men in Washington, specialists and gentlemen of culture in Baltimore, have all coöperated with the Provost of the Peabody Institute in his laborious and responsible work of choosing a library for scholars. At first there was naturally little demand for the original sources of knowledge, works of science in foreign languages, the collections of learned societies, and the proceedings of the great academies of Europe. "We cannot create scholars or readers to use our library," said the Provost, in an address to the public in 1871, "but we can make a collection of books which all scholars will appreciate when they shall appear among us, as they surely will some day." That day has come. Already in 1871, the idea of founding a great university was in the mind of Johns Hopkins, and already he had chosen upon his board of trustees several of the managers of the Peabody trust. The two institutions now supplement one another. A learned foundation is slowly building, with a library of research for its corner-stone.

The Johns Hopkins University does not attempt to duplicate collections already existing in Baltimore, unless there is some special demand. The institution enjoys the incalculable advantage of free access to the Peabody Library. One or two University classes meet in a small lecture-room of the Institute for the sake of using its valuable resources. The same privileges are accorded by the Maryland Historical Society, where also University classes have met, and where there is an excellent collection of Americana—manuscripts, pamphlets, and files of old newspapers, some of which latter have been utilised by Von Holst in his studies for the "Constitutional History of the United States." By the courtesy of members of the Baltimore bar, the Law Library is also made easy of access to advanced students of history and political science. The Maryland Episcopal Library, the legacy of the late Right Rev. W. R. Whittingham to his diocese—a unique collection of ecclesiastical literature (Catholic and Protestant), comprising ancient folios and rare editions of the classics, church fathers, and schoolmen—this modern cloister is open to advanced students of church history and institutions. The library of the Johns Hopkins has a character quite its own. In point of size this collection, now numbering about 11,700 bound volumes, is inferior to five other libraries in Baltimore, that of the Peabody Institute (73,000), Mercantile (37,000), Maryland Institute (19,000), Odd Fellows' (20,500), Maryland Historical Society (17,000). But it would be unjust to measure the efficiency of the University library by any material scale. At the outset the trustees of the Johns Hopkins seem to have conceived the idea that a library should form an organic part of University work. The newly-appointed professors, associates and fellows were consulted as to what books they needed for the immediate prosecution of their researches, and those books were first ordered. From the very foundation, the library has grown in the direction of special working-collections, rather than of a library-museum. Small department-libraries have been formed in separate rooms, with facilities for quiet research. The systematic policy of the University has been toward colonizing special libraries in the very class-rooms and work-shops. The chemists have long had their own reference-library in the laboratory-building, so that students, without personal inconvenience or neglect of work in hand, can look up special points in any of the complete sets of chemical journals, Liebig's *Annalen*, and the like. The Professor of Greek has his seminary-library, and other departments are working in the same direction.

In addition to these special libraries, there is a University reading-room, which is the favorite resort of students and instructors, and is, on the whole, a unique place. Large, comfortable, attractively furnished, well-lighted and cheery, it may be termed a University parlor, or the Johns Hopkins family library, where all departments are entirely at home, and where every member of the University household can help himself to books or periodicals. There is no obstructive policy on the part of librarians. The books are upon open shelves, and within easy reach from the floor. The collection contains chiefly works for general reference, not merely encyclopædias, dictionaries of various languages, maps, hand-books of biography, art, and science, but also works of classic, Germanic, French, and English literature, history, philosophy, and science—standard books which not merely persons of liberal culture, but even so-called "narrow specialists" have frequent occasion to consult. Men take the volumes they want, sit down at one of the long tables, and work quietly, without asking questions, for everybody seems to know where everything is to be found. When they have finished, they return the books to their places, as though they belonged to a private library. If a book is to be taken away, of course it must be charged by the library attendant, who employs a card-system of receipts and keeps an alphabetical account of all absent volumes, which may be recalled if demand arises, but which otherwise may be renewed from time to time. In the reading-room may also be found, arranged by departments upon long tables, a remarkable collection of periodicals, published in various countries—England, Scotland, France, Germany, Austria, Holland, Belgium, Italy, Greece, India, and the United States. Some of these foreign periodicals are the proceedings of royal academies and learned societies, notably of London, Edinburgh, Dublin, Paris, Berlin, Vienna, St. Petersburg, Copenhagen, Rome, Venice, and Calcutta; and some of them are received in exchange for the mathematical, philological, and other scientific publications of the University.

One of the most interesting features, perhaps, of the library management is the so-called "new-book department," for the exhibition, in a special case, or occasionally upon long tables in the reading-room, of new French, German, and English books which may be of special value to University men. Copies of these books may be recommended for the library by instructors, and permanently retained, or may be disposed of to individuals. Nothing is ordered for the mere sake of possession. Value in use and the law of demand and supply control the choice of books. The main idea is to keep pace with the progress of science and with the advancing needs of specialists. Instead, therefore, of becoming simply an interesting cabinet of literary curiosities, the University library has always been a busy laboratory of science, where new truth is discovered by a study of its living forms.

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CALENDAR, 1881-82.

September 20.	**Current Academic Year Began.**
June 5—8.	**Matriculation Examinations.**
June 9.	**Term of Instruction Closes.**
September 19.	**Next Academic Year Begins.**
September 20—23.	**Matriculation Examinations.**
September 26.	**Instructions Resumed.**

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MEETINGS OF SOCIETIES.

Scientific. First Wednesday of each month, at 8 P. M.
S. H. Freeman, Secretary.

Philological. First Friday of each month, at 12 M.
M. Warren, Secretary.

Metaphysical. Second Tuesday of each month, at 8 P. M.
B. I. Gilman, Secretary.

Historical and Political Science. Third Friday of each month, at 8 P. M.
H. B. Adams, Secretary.

Mathematical. Third Wednesday of each month, at 8 P. M.
O. H. Mitchell, Secretary.

Naturalists' Field Club. Excursions each Saturday during the Spring and Autumn. Regular meetings for the reading and discussion of papers once a month.
H. F. Reid, Secretary.

PROCEEDINGS OF UNIVERSITY SOCIETIES.

Abstracts of the More Important Papers Read at Recent Meetings.

Scientific Association.

January meeting.

Smoke Ring Phenomena, by R. W. Prentiss.

These phenomena take place in what are called smoke or vortex rings, the particles of smoke showing the vortex motion of the air in which they are suspended. For the purposes of experiment and illustration they are generally made by generating smoke in a box and driving it out suddenly through a circular aperture in the side of the box; they are also familiar as the rings produced by smokers. It is well-known that when one of these rings is projected into the air it moves forward with a gradually decreasing velocity, slowly increasing in diameter until it is finally destroyed by friction and currents of air. A mathematical investigation of the motion of the air outside the ring shows that it is flowing through and about the ring in the direction of the motion of the ring. So that if two rings are formed having a common axis of projection and very nearly equal velocities, the one behind moving a little the faster, the second ring will pass through the first and then the first will pass through the second, &c., &c.; the rings changing position throughout the motion. One ring revolves about the other. It is, however, generally difficult to realize this phenomenon in experiment. When one ring is projected directly after another it slowly increases in velocity and decreases in radius until quite near the first ring when it suddenly and rapidly increases in velocity, passes through the first ring and then immediately expands to allow the first to pass through it, and this ring goes through a similar course. Produced in this way, the revolution is quite violent, and the rings are generally broken up and destroyed after only two or three revolutions. The motion, however, approaches uniformity as the velocities and circumstances under which the rings are produced are more nearly alike. One of the singular phenomena to which attention was called is the production of two rings, one smaller than the other, by the same impulse, the one revolving about the other with quite uniform motion, in accordance with the principles for the motion of two rings.

But the rings are not generally of equal density throughout, the smoke accumulates in the lower parts and the motion becomes unequal, giving rise to the second phenomenon. As the motion ceases, the dense portion of the smaller ring lags behind and falls down in a loop, while the upper portion continues its motion about the main ring, winding itself about it. The loop is drawn out into two long filaments, while the bottom of the loop separates into two strands or rolls of smoke connected by a thin sheet of smoke which finally disappears. These two strands together assume a circular shape, while the main filaments fall down in two loops through this ring, forming altogether a delicate and well defined figure, somewhat similar to the outline of a basket. This phenomenon also takes place when very dense single rings are formed; successive portions of the ring fall down in loops, each of which finally assumes the figure described above. These facts, capable of observation, seem to indicate that the whole ring is a sheet of smoke, made up of a series of still smaller successive rings. It is, in shape, like the surface generated by a plane spiral revolving about an axis in its plane. Each point of such a spiral would describe a circle which would be the circular axis of one of these constituent rings. If at any time this surface separates into two parts along one of the rings, each part keeps up the spiral motion, folding up (as a coat sleeve is folded up) into a separate ring similar to the original; and we have the case of the two rings. If the separation takes place along the lower part of one of the rings, we have the second phenomenon described above. The separated part folds up into a half ring or loop, giving rise to the *basket* outline, while the upper portion continues its motion with the main part of the ring. A quite distinct phenomenon results when a dense portion of the ring falls rapidly down. The resistance and friction of the air produces vortex motion in the outer part of the mass which gradually results in the production of a complete vortex ring.

On a Logical Problem connected with Assurances on Joint Lives, by J. J. Sylvester and F. Franklin.

Dr. Franklin stated, at the request of Professor Sylvester, some formulae obtained by the latter relating to the enumeration of objects grouped in classes, and showed how these formulae may be obtained by the rules of symbolic logic. The determination of the totient of a number, and the deduction of the values of survivorship annuities from tables of joint-life annuities, are instances of the application of Professor Sylvester's formulae.

Salpa and the Discovery of Alternations of Generations, by W. K. Brooks.

"Some years ago I became convinced, from the study of living specimens of Salpa, that the two forms, the chain salpa and the solitary salpa, are male and female, and that the single egg which each chain salpa contains at birth, passes into its body before birth, from the ovary of the solitary salpa, which is therefore the true female. I then asserted that salpa is not an example of alternation of sexual with sexless generations, and that Chamisso discovered a great natural law through an error. As my conclusion has never been accepted by other naturalists I have, for some years, watched for an opportunity to review the subject, and Professor Baird has afforded me the desired opportunity this winter, by furnishing me a supply of perfectly preserved specimens.

"The study of these specimens has afforded a complete confirmation of my view, as I have been able to procure a complete series of microscopic sections, showing the eggs at all stages, from the time when they originate in the ovary of the solitary salpa to the time of impregnation in the body of the male nurse."

February meeting.

On the New Dividing Engine, by H. A. Rowland.

On the Oxidation of Di-ethyl-benzol Sulphamide, by W. A. Noyes.

It was found that when para-di-ethyl-benzol sulphamide is oxidized with potassium pyrochromate, sulphuric acid and water, a mono-basic acid containing one less carbon atom is obtained. The second ethyl group is neither oxidized nor broken down to a methyl group.

The presumption that the unoxidized ethyl group is in the ortho position to the sulphamide group is very strong, both because, in compounds containing two methyl groups with a "negative" atom or group, it is always the ortho methyl which is protected, and because in all known cases where we have sulphamide and carboxyl groups in the ortho position they form a sulphinide. This acid is not a sulphinide.

This case is of especial interest as showing that the law, stated by Professor Remsen several years ago, with regard to the oxidation of benzol derivatives, may hold true when a larger group than methyl is to be protected.

On the Effects of a Gradual Rise of Temperature on Reflex Actions in the Frog, by W. T. Sedgwick.

An abstract of this paper is given on page 180 of *University Circular, No.* 13.

March meeting.

On the Geometrical Forms called Trees, by Prof. A. Cayley.

The object was to recall attention to the remarkable theorem (due as the author believes to Prof. Sylvester or M. Camille Jordan) that every tree has in two different senses of the word a centre or a bicentre, viz: a centre or a bicentre of length, and a centre or a bicentre of number. *First*, we consider the length of the several branches which proceed from any knot (the length between consecutive knots being taken as unity)—the theorem is that there is always a knot (and one knot only) from which proceed two or more longest branches; or else a pair (and only one pair) of adjacent knots such that from the two knots proceed two or more longest branches, one at least from each of the two knots; we have thus a centre or a bicentre of length. *Secondly*, we consider the number of knots upon the several branches which proceed from any knot; if for any knot these numbers are for instance $\alpha, \beta, \gamma, \delta, \varepsilon$ then, 1° every sum $\beta+\gamma+\delta+\varepsilon$ of all but one of these numbers is at least $=$ remaining number α; or else, 2° there is a term α which is $=\beta+\gamma+\delta+\varepsilon+1$; or else 3° there is a term α which is greater than $\beta+\gamma+\delta+\varepsilon+1$. The theorem is that there is always one (and only one) knot for which the numbers on the several branches proceeding from it, are as in 1°, or else there are two (and only two) knots (and these a pair of adjacent knots) such that for each the numbers on the several branches proceeding from it are as in 2°. We have thus a centre or a bicentre of number.

In connexion with the reference to his name in the above Prof. Sylvester stated that to M. Camille Jordan was due the credit of being

the first to discover the existence of the centre or centre-pair of each kind described in the above note. In entire ignorance of M. Jordan's work he rediscovered for himself the centre or centre-pair of the first kind, and was the first to make use of the method immediately flowing therefrom to solve the problem of finding the forms and the number of tree-graphs* corresponding to a hydro-carbon or hypothetical hydro-boron series with a given number of carbon atoms. His results, which he communicated from time to time to Prof. Tait, of Edinburgh, were however as regards the ascertainment of the number of such graphs, purely arithmetical, but giving all the different forms of the so-called trees or (more properly speaking) ramifications for different values of the number of atoms up to a certain arithmetical limit. The problem was subsequently taken up from this point by Prof. Cayley, who obtained general generating-function formulæ for effecting the denumeration of the graphs. Mr. Sylvester then proceeded to explain his method of arriving at the first kind of centre or centre-pair of any given tree or ramification.

To this end he supposes all the terminal branches of the tree removed. A tree with a less number of nodes is thus brought into evidence which is subjected (if possible) to like treatment and so a third tree with still fewer nodes is arrived at. As this process cannot be indefinitely continued (for if so a finite number could be continually diminished) we must at length come to a tree or ramification whose terminal branches cannot be removed without leaving nothing in the form of a tree remaining. So long as not less than three nodes remain, since they must not form a triangle, for that would be inconsistent with their appertaining to a ramification, the process of lopping off terminals cannot be brought to a close. Eventually, therefore, this process must lead to a system of branches all radiating out from a single point, or which being removed, only an isolated point remains, or else to a sort of double-headed mop or broom consisting of two such radiating systems stuck into the two ends of an axis. This is the case of bicentric or axial, the former of a monocentric ramification. Thus every ramification may be said to belong either to a central or an axial class. He concluded with suggesting that some general chemical or physical property or set of such properties might reasonably be supposed to exist serving to distinguish between these two classes or genera in the case of the well developed series of the hydro-carbons.

On the Influence of Changes of Arterial Pressure upon the Pulse Rate in the Frog and the Terrapin, by W. H. HOWELL and M. WARFIELD.

The paper gave an account of some experiments upon the isolated heart of the frog and the terrapin, similar to those carried out by Prof. Martin upon the isolated mammalian heart.

The method used in isolating the heart was to ligature all the great veins and arteries leading to and from the heart, with the exception of the vena cava inferior and one of the aortas; the former of these was connected with Marriotte's flasks containing defibrinated calf's blood diluted with an equal bulk of sodium chloride solution 0.6 per cent., which served to nourish the heart, while the latter was connected with a manometer which recorded the heart beats, and with an outflow tube, by raising or lowering which arterial pressure was varied.

All central nervous influence was removed from the heart by cutting the vagi and the sympathetics, and pithing the cervical spinal cord.

A new water manometer was described, which gives much more accurate tracings than the ordinary mercury manometer, and registers smaller variations of pressure. As the general result of the experiments, it was stated that variation of arterial pressure up to the highest point of normal blood pressure, has no direct effect whatever upon the pulse rate of the isolated heart of the frog or of the terrapin; confirming for these hearts the results obtained by Prof. Martin from the isolated mammalian heart.

On the Nature of the Molecule of Ozone, by IRA REMSEN.

Some recent experiments have shown that nascent oxygen has the power to oxidize carbon monoxide to the dioxide. Ozone has not this power. Now when ozone is transformed into oxygen by heat, free atoms of oxygen or nascent oxygen ought to be formed, if the commonly accepted ideas regarding the nature of the ozone molecule are correct. Experiments recently performed under the speaker's direction by Mr. E. H. Keiser, show that when carbon monoxide and ozone are heated together until all the latter is transformed into oxygen, the former is not oxidized. This result cannot readily be explained. A full discussion of the subject will be given in the *American Chemical Journal* for April.

April meeting.

On the 8-Square Imaginaries, by PROF. A. CAYLEY.

These are the system composed of unity and seven imaginaries (analogous to the 1, i, j, k of quaternions) and connected with the 8-square formula in the same way that the quaternion symbols are connected with the 4-square formula (or formula for the expression, as a sum of four squares, of the product of two sums each of four squares). It is shown that the new imaginaries are of necessity non-associative. As regards the quaternion symbols the definition of the relations between the symbols has reference to the only triad ijk which can be formed with the symbols—in the case in hand the definition depends upon 7 out of the 35 triads; and if for instance i, j, m belong to any one of the remaining 28 triads, then these three symbols are non-associative, but are such that $i.jm = -ij.m$. The paper will be published in the *American Journal of Mathematics.*

With reference to the above communication PROF. SYLVESTER referred to the general question of representing the product of sums of two, four or eight squares under the form of a like sum, and mentioned that Prof. Cayley had been the first to demonstrate, by an exhaustive investigation, the impossibility of extending the law applicable to 2, 4 and 8 to the case of 16 squares. The new kind of so-called imaginaries referred to by Prof. Cayley are, as far as Mr. Sylvester is aware, the first example of the introduction into Analysis of locative symbols not subject to the strict law of association, and he considers the law regulating the connexion of the two products represented by a succession of three such symbols, most interesting, inasmuch as such products are either identical, or if not identical, of the same absolute value, but with contrary signs: most persons, before this example had been brought forward, would have felt inclined to doubt the possibility of locative symbols (*vulgo* imaginary quantities)* whose multiplication table should give results inconsistent with the common associative law, being capable of forming the groundwork of any real accession to algebraical science—the results of Prof. Cayley referred to above, seem to show that such doubts are open to question. Mr. Sylvester mentioned as bearing upon the subject of so-called imaginary quantities, that in his recent researches in Multiple Algebra he had come upon a system of Nonions, the exact analogues of the Hamiltonian Quaternions and like them capable of being represented by square matrices. Mr. Charles S. Peirce, it should be stated, had to the certain knowledge of Mr. Sylvester arrived at the same result many years ago in connexion with his theory of the *logic of relatives*; but whether this result had been published by Mr. Peirce, he was unable to say.†

On Concave Gratings, by H. A. ROWLAND.

On Animal Polymorphism, by E. B. WILSON.

This paper gave a brief discussion of the nature of polymorphism in animal colonies, with especial reference to the so-called polymorphism of the Pennatulacea. In studying the development of the colony in *Renilla*, it was found that the peculiar and characteristic mode of budding shown by the sexual polyps is characteristic also of the rudimentary polyps or "zooids." There is a manifest relation between this mode of budding in the sexual polyps and the environment of the organism, and in view of the structure of other Pennatulacea, we seem to be justified in the conclusion, in accordance with the prevailing views of symmetry, that the mode of budding in the sexual polyps is directly dependent on the relation of the organism to its environment. If this conclusion is well-founded, then it follows with considerable probability that the rudimentary zooids cannot have acquired their present mode of budding in their present position, for they agree with the sexual polyps in the law of budding, but differ widely from them in their relation to the environment. And furthermore it is impossible to conceive how the zooids can ever have occupied such a position as to agree with the sexual polyps in this relation.

From these considerations it seems probable that the zooids are not degenerated polyps but are new formations which have inherited certain peculiarities from the sexual polyps. It is immaterial whether we call them organs which simulate individuals, or individuals in a state of arrested development; in either case the various members of the

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*In accordance with the nomenclature employed above, the writer uses here occasionally the word *tree*, but considers his original word *ramification* more correct. A tree is a ramification with one point fixed as a root or origin, and no such fixed origin is supposed to exist in the graphs in question.

*Using θ, h, t, u to denote thousands, hundreds, units, tens, the year of grace in which we live may be represented by $\theta + 8h + 8t + 2u$, θ, h, t, u, being locative symbols which it would be absurd to style *imaginary quantities*; but they are as much entitled to that name as the i, j, k, or any like set of symbols—the only essential difference being that the one set of symbols is limited, the other unlimited in number—and accordingly the law of combination of the one set is given by a finite and of the other set by an infinite *multiplication table*. We might mark off the specific difference between the two cases, by defining the latter set as *unlimited*, the former as *recurrent* or *periodic* locatives or locators; the *locatives* indicate out of what *basket*, so to say, the *quantities* appearing in an analytical expression are to be selected—the multiplication table determines the basket into which their product is to be thrown. Under a purely analytical point of view this is all that is wanted—but in the application of quaternions to problems in nature, it becomes necessary to give special significance to the baskets or rubrics (which would do as well) to which the quantities belong and understand them to signify that certain geometrical processes of *setting* are to be performed.

The true analytical theory of quaternions has nothing to do with this setting part of the business, and regards quaternions as matrices of the second order of a certain determinate form, and accordingly the whole analytical side of the theory of quaternions merges into a particular case of the general theory of *Multiple Algebra*.

As far as the present writer is aware, Professor Cayley in his memoir on Matrices, (Phil. Trans., 1858), was the first to recognize the parallelism between quaternions and matrices, but the idea and method of effecting their complete identification is due to the late Prof. Benjamin Peirce or to his son Mr. C. S. Peirce.

†Mr. C. S. Peirce gave a form of this Algebra in a paper "On a Notation for the Logic of Relatives," published in 1870. The class of Associative Algebras to which this belongs were termed *quadrates* by the late Professor Clifford. [*Communicated to the Editor by Mr. Peirce.*]

from these parish beginnings. Mayor Courtenay, of Charleston, in his recent address on education in South Carolina, leaves the erroneous impression that free schools were not instituted in that State until 1811, whereas they were really erected in many parishes and districts at a much earlier period. As far back as 1710, a free school was established in Charleston. Similar institutions were planted at Dorchester, Childsbury, Beaufort, Ninety-Six, St. Thomas' Parish, St. James, Santee, and elsewhere Many of these schools owe their origin to legacies bequeathed them by generous parishioners, like Beresford, Ludlam, Childs, and others. Dorchester was settled by a colony of Congregationalists from Dorchester, Massachusetts. This little colony, the offshoot of the best type of a parish town in New England, emigrated to South Carolina about the beginning of the last century and settled in a place which they called after their old parish-home. These democratic Puritans brought with them their love of popular education, and, through legislative coöperation, established a free school in Dorchester, S. C., in the year 1724, which school was long maintained by its liberal founders. With the growth of primary education, the demand for the higher education increased, resulting in the establishment of no less than five colleges and several academies before the expiration of the eighteenth century. Many charitable societies also maintained schools, usually for the education of the poor. In some cases even slaves were taught to read. The State constantly encouraged education by donations, immunities, and by vesting in school-boards escheated property in villages or parishes. In 1801, the South Carolina College was founded. By the year 1811, the demand for popular education had so increased and the country was being so rapidly settled that a general system of free schools was inaugurated. From this time on there was a steady increase in educational facilities until the outbreak of the civil war.

Early English Military Institutions, by E. R. L. Gould.

Blackstone says Alfred was the first to create a national militia in England. No record remains of the laws of this king which justify such a statement. Indeed there is a great dearth of martial legislation throughout the early English period. The military organization of the Saxons in England can be understood only through a study of their civil institutions, which, in many cases, are evidently the outgrowth of military beginnings. There is a very close connection between the organization of early England and of ancient Germany, as regards civil and military matters. The tithing, hundred, and shire correspond, in certain respects, to the *vicus*, *pagus*, and *civitas*. described in the *Germania* of Tacitus. The *comitatus* of the German local *principes* is seen in the company of thegns attached to a petty English king, ealdorman, or bishop. The body of personal followers was a kind of standing army, independent of the local militia. There are many striking resemblances between the warlike institutions of the early Teutons and of the Vedic peoples of ancient India. The military constitution of early England probably sprang from the martial customs of the Aryan race. There is a perfect historic continuity in the main idea of the militia system. namely, liability of the entire mass of able-bodied men to serve as a *Landsturm*. Occasional military service appears to have been a kind of tax paid by the citizen to the commonwealth, whether national or tribal. In ancient India and Germany, as well as in early England, the leaders of the martial host, which was gathered from local precincts. were also the governing authorities of those precincts in time of peace.

Review of the Situation in Dalmatia, with extracts from MS. letters by Arthur Evans, Ragusa Correspondent of the *Manchester Guardian*, and by Edward A. Freeman, D. C. L., read by H. B. Adams.

March meeting.

Local Government in New York, by E. W. Bemis.

The management of local affairs in New Netherlands was in the hands of village magistrates nominated by the people and confirmed by the Governor. With the influx of immigrants from New England, after the conquest of New Netherlands by the English, in 1664, came important modifications of the Dutch system of local government. In 1684, New York was divided into counties. This English unit of administration still retains an important place in the local autonomy of the above State. The county is composed of towns from thirty to sixty square miles in area. Powers of county legislation are invested in county boards consisting of the supervisors or heads of the several towns forming the larger unit. The county boards issue warrants for the collection of all taxes in support of roads, bridges, the erection of court houses, and other county purposes. Town assessors report to the county authorities. All purely local officers are elected by the towns in town meeting assembled. The towns can make by-laws and establish penalties for local offences; they can regulate their own common schools, common lands, fences, and town property; they can raise money by local taxation for public uses, such as roads and bridges, if more than the county allowance is needed. The distinguishing feature of the New York system of local government, as compared with the New England system, is the great power of the county in control of its towns. New York has a compromise system, combining the best features of the New England town and of the Southern county. From the New York system has developed that of Illinois, Michigan, and Wisconsin.

Local Self-Government in Pennsylvania, by E. R. L. Gould.

In early colonial times, under the administration of the Duke of York, the town or parish was the centre of local life. County government did not practically exist. All town officers were under the management of a constable and a board of overseers, who promulgated constitutions and by-laws and adjudicated petty cases in the "Towne Court." This body also looked after the ecclesiastical interests of the parish. The local administration of this period was essentially a reproduction of the English system. In the early stages of Proprietary rule the town lost its former position and the county became most prominent. The County Court of Quarter Sessions was the centre of authority, and rates were levied, roads opened, bridges constructed, and the poor cared for under county direction. Subsequently the charge of paupers and highways was transferred to the township, on which the overseers and supervisors laid rates to cover expenditure entailed by these burdens.

The Pennsylvania system at the present time is a compromise between the town polity of New England and the county administration of the Southern States The system aims at a partition of powers. There is no town meeting where the people may come together and frame by-laws for their own government. Neither is the township represented by a supervisor upon the County Board as in New York, Michigan, Illinois, and other of the Northern and North-western States. The township officers have the power to levy a road tax, but only on the basis of the last adjusted county valuation. County assessments are made to defray the ordinary expenses of local government. The poor are usually, though not always, a county charge, and when such is the case are supported from the general county fund. The county is the leading local unit and. under the commonwealth, may be said to wield the largest share of political power. It regulates affairs directly and its officers are responsible to the people for the exercise of administrative control. (This paper was read before the Pennsylvania Historical Society, May 1, 1882, and is now in press).

Local Self-Government in Illinois, by Albert Shaw.

The local institutions of the West are not novelties nor experiments. In main features they reproduce those social arrangements under which the Anglo-Saxon insists upon living, wherever he may be transplanted. Illinois may be taken as the model western State in respect to local government. The precise form which its institutions have assumed has been largely shaped by the State's history. Illinois illustrates the tendency of migration to follow the parallels of latitude. Its southern half was peopled from Southern States, especially Virginia, while men from New England and New York occupied the northern half. The settlers brought their ideas and habits with them. The New England men came from self-governing agricultural communities, where the people made laws, chose officers and voted local taxes in the democratic "town meeting." The New England county was little more than a name; the township was the real political unit. The Virginia settlers, on the other hand, had not been accustomed to organized neighborhood life or to local self-government. In the States of the South, county officers appointed by the State government administered State laws.

Illinois passed from French to English hands in 1763, and was in 1778 made a Virginia county. A decade later it passed under the government established by the Ordinance of 1787, which confirmed forever to the people many great principles. In 1818 it was admitted as a State Its early connection with Virginia, as well as the temporary government erected under the Ordinance, had already given a southern cast to its administrative forms. The southern half of the State alone being settled at the time of its admission to the Union, the Constitution of 1818, naturally, provided for a county system similar to Virginia's. Southern migration to Illinois declined after the Missouri Compromise of 1820, and Northern people filled up the State. The new Constitution of 1848 compromised with the two systems of local government by providing that counties might, on popular vote, be placed under township organization. The northern counties at once adopted the township system, southern counties remaining under the county system. At the present time about four-fifths of the 102 counties in the State are under township government. This result was materially furthered by the U. S. Land Survey system, which divided the public domain into townships, and allotted land in each township for school purposes.

The annual "town meeting" of the whole voting population is the central fact in township government. At this meeting the people elect local officers, discuss neighborhood interests, vote taxes and enact by-laws and rules covering a wide range of local topics. The Supervisor is the business officer of the township, and the Supervisors of the several townships constitute a County Board which manages county affairs. Highways and schools are provided for by the townships, while the care of the poor is entrusted either to the county or the townships as the people may determine. Each township elects two justices of the peace. The county maintains a judicial establishment and controls matters which concern the townships in common. As in the South, so in Illinois and throughout the West the county is the political unit within the State. General laws provide for the incorporation and municipal government of "villages" and "cities," requiring a minimum population of 300 for the former, and of 1000 for the latter. The compass of this abstract precludes details of county, township, and municipal governments as provided for in the statutes of Illinois.

Administration of the City of Berlin, by Richard T. Ely.

Berlin, like other German cities, occupies somewhat the same position with regard to the state government exercising control over it, that the German states do with reference to the Empire or our states with reference to the Federal Government at Washington. But the government of Berlin resembles an American State more closely than it does a German one. It is republican with an aristocratic tendency. The citizens are divided into three classes according to the taxes they pay. The first class includes the highest tax payers. It begins with the citizen paying the highest tax and ends when enough of the largest tax payers are included, so that the sum total of the taxes they pay is equal to one-third of the taxes paid by the citizens of the municipality. The second class comprises in similar manner those who pay the second third of the entire tax. The third class embraces those who are left—the poorest citizens. Each class has the same number of representatives in the city assembly, which is a body corresponding to a state legislature. It consists of 108 members, which ought not to be considered too large to represent properly a city containing over one million inhabitants. The representatives in the municipal assembly are elected for six years, the term of one-third expiring every two years. They receive no pay, as their office is what the Germans call an *Ehrenamt*—a place of honor. One-half of them must possess houses.

The executive branch of the city government is the magistracy, a collegiate body, consisting of thirty-four members. The *Oberbürgermeister* (chief mayor) and *Bürgermeister* (mayor) are at the head of the magistracy. The chief mayor, mayor, and other paid magistrates, whose whole time is consumed by their official duties, are elected for twelve years. The other magistrates are elected for six years, one-half retiring at the expiration of each three years. The members of the magistracy must be confirmed by the King.

The higher officers in Berlin, as in other Prussian cities, must be appointed for life. This is one of the provisions of the municipal law of Prussia. This avoids rings and machine politics. The life appointees have proved faithful and honest in Berlin as in Vienna. This is a better device for getting rid of rings than the one a number of American cities appear disposed to try, namely, that of making the mayor absolute. We have already too many forms of despotism in this country.

The net expenditures of the city government of Berlin in 1876 were considerably less than $7,000,000. One single item in the cost of the municipal administration of New York city for 1881 exceeded this by over $1,000,000. This was the interest on the city debt.

The paper, of which the above is a brief abstract, appeared in *The Nation*, New York, March 23 and 30, 1882.

The Institutions of North Carolina, by Henry E. Shepherd.

No one of the original thirteen States preserved, with more devoted tenacity, the form and the spirit of English institutions than North Carolina. In some instances antiquated usages were retained after their final abolition in England; as for example, benefit of clergy, abolished in England in 1827, but in force in North Carolina until 1855. The North Carolina Bill of Rights, and the Halifax Constitution, Dec., 1776, were largely drawn in language, as well as in spirit, from Magna Charta and the English Bill of Rights. This can be ascertained by the most casual examination of the several documents. The strictest property qualifications were requisite to render eligible to membership in either branch of the Legislature, or to the right of voting for members of the Senate. In accordance with a genuine English tradition, property in land was looked upon as the basis of civic freedom. The popular branch of the general assembly was known as the House of Commons, a simple transfer of the English designation.

British statutes have been reënacted in North Carolina, and the common law repeatedly declared in force. Modes and forms of procedure have been introduced from England, and the decisions of the Supreme Court largely controlled by a strict regard to English precedent. Sir Edward Coke has ever been revered as the oracle of the common law, and American commentators accepted with reserve if not with distrust.

The character of legislation in the State has been in great measure affected by English precedents; as for example, the revolution of 1688. Thus the XXXII Article of the North Carolina Constitution of 1776, imposing disabilities upon Roman Catholics, was inspired by the bitter memories of James II's time. In this same Constitution the sixth section of the Act of Settlement is substantially reënacted. Borough representation prevailed in North Carolina until the adoption of the amended Constitution, 1835, three years later than the passage of the memorable English Reform Bill, which destroyed so many "rotten" boroughs.

Until 1835, the General Assembly met annually, and the Governor was elected annually by the General Assembly. The morbid dread of executive usurpation or encroachment which animated the leading spirits of '76, impelled them to reduce the office of Governor to a mere phantom, destitute of authority or dignity. The reformed Constitutions, adopted in accordance with the Reconstruction Acts, have destroyed much of what was antiquated and venerable in the legal and political system of North Carolina.

Review of Professor C. K. Adams's "Manual of Historical Literature," by H. B. Adams.

April meeting.

Markets, Fairs, and the Atlanta Exposition, by B. J. Ramage.

The national fair at Atlanta forms an interesting chapter in institutional history. It must be looked upon as the historic outgrowth of old English fairs and markets, which were reproduced in this country at a very early date. In all countries where inter-communication is slow, fairs are a very necessary institution. They are held several times a year at specified places, and are the distributing centres of all slightly advanced societies. "What we know as a fair," says Herbert Spencer, "is the commercial wave in its first form." In ancient times neighboring tribes, in order to avoid any disputes in regard to boundary lines, always left an open, neutral tract, *e. g.*, the *mearc* or *march*, between their different village communities. Here it was safe for merchants to come with their wares, and here also treaties were made. Hence Hermes, who was the god of boundaries, was also the guardian of merchants and ambassadors. The intimate connection between fairs and markets, and the growth of international ideas is thus clearly seen. The Roman *jus gentium*, according to Sir Henry Maine, was the outcome of old market law. The English fairs and markets are of remote origin. A study of ancient Anglo-Saxon law will show the high estimate which early English kings put upon these institutions. No fair or market could exist without a grant or prescriptive right. Two courts of an inferior nature were attached to these fairs and markets. One was the clerk of the market's court, and the other was the court of *pie poudre*. The former, presided over by the clerk of the market, the old Saxon portreeve, had cognizance of various violations of market regulations, such as forestalling, regrating, the use of false weights and measures, etc. The court of *pie poudre*, so called from the dusty feet of the suitors, who usually attended the fairs on foot, was established for securing summary justice, and was presided over by the steward of the lord of the fair. Each lord of the fair had the right to collect toll, which was defined by Edward the Confessor to be "*libertatem emendi et vendendi in terra sua*." This old toll, which dates far back in early English history, seems also to have at times partaken of the nature of an *earnest* or *partial* payment, and still lives on in many rural districts, where persons entering on a contract are accustomed to exchange a button or a piece of metal as a pledge of good faith. The "Mirrour of Justice," in describing the abhorrence of the Anglo-Saxons for all secret contracts, defines the toll as an expedient for compelling open contracts. The universality of fairs held in all lands, from ancient India to the Aztec cities of Mexico, shows that it is a mistaken view to regard them as of Church origin, though they were considerably influenced by the Church. The latter, however, built itself and its various fairs and festivals upon institutions already existing. These old English fairs and markets, with all their peculiar historic characteristics, were transplanted to the English colonies in America, and were encouraged by statutory law in New York, Massachusetts, Maryland, Virginia, the Carolinas, and elsewhere. With the increased growth of commercial centres and improved means of inter-communication, these old institutions, while losing almost entirely their commercial importance, still live in the various county and state fairs and exhibitions. The same causes and influences which have resulted in the world fairs of Europe, at Paris, London, Dublin, Amsterdam, and other cities, with all the attendant influences upon the growth of international ideas, and the higher development of the commercial *jus gentium*, have also slowly been at work in America. New York and Philadelphia have each had an International Exposition, and Atlanta, the *market* town of the New South, the chosen *march*, where Northern and Southern ideas are interchanging, has just closed a great national fair, which has had many wholesome influences upon all sections of the Union.

Note of the Discovery of a Court Leet upon St. Clement's Manor, in St. Mary's, by John Johnson.

No authentic instance of a Court Leet can be found in the written history of Maryland. Even the existence of the institution, either in this province or under the proprietary government of Pennsylvania, is denied by some writers. Recent investigations concerning the manorial system first surface at the point (xyz); also let $\alpha\beta\gamma$ denote the direction cosines of the normal to the second surface at the corresponding point $(\xi\eta\zeta)$. We have then

$$a,\ b,\ c = \frac{dy}{du}\frac{dz}{dv} - \frac{dz}{dv}\frac{dy}{du} \div \sqrt{EG - F^2},$$
$$\frac{dz}{du}\frac{dx}{dv} - \frac{dz}{dv}\frac{dx}{du} \div \quad \text{''}$$
$$\frac{dx}{du}\frac{dy}{dv} - \frac{dx}{du}\frac{dy}{dv} \div \quad \text{''}$$

similar values for α, β, γ. Write these as

$$a,\ b,\ c = \frac{A}{V},\ \frac{B}{V},\ \frac{C}{V}$$

and

$$\alpha,\ \beta,\ \gamma = \frac{A'}{V'},\ \frac{B'}{V'},\ \frac{C'}{V'}.$$

Then we have at once

$$V = aA + bB + cC,$$
$$V' = \alpha A' + \beta B' + \gamma C',$$

and

$$dS = V\,du\,dv,$$
$$d\Sigma = V'\,du\,dv,$$

then

$$\frac{d\Sigma}{dS} = \frac{V'}{V}.$$

Now obviously

$$V = \begin{vmatrix} a & b & c \\ \frac{dx}{du} & \frac{dy}{du} & \frac{dz}{du} \\ \frac{dx}{dv} & \frac{dy}{dv} & \frac{dz}{dv} \end{vmatrix}$$

$$V' = \begin{vmatrix} \alpha & \beta & \gamma \\ \frac{d\xi}{dx}\frac{dx}{du} + \ldots, & \frac{d\eta}{dx}\frac{dx}{du} + \ldots, & \frac{d\zeta}{dx}\frac{dx}{du} + \ldots \\ \frac{d\xi}{dx}\frac{dx}{dv} + \ldots, & \frac{d\eta}{dx}\frac{dx}{dv} + \ldots, & \frac{d\zeta}{dx}\frac{dx}{dv} + \ldots \end{vmatrix}.$$

Border this by

$$0,\ a\frac{dx}{du} + b\frac{dy}{du} + c\frac{dz}{du},\ a\frac{dx}{dv} + b\frac{dy}{dv} + c\frac{dz}{dv},\ a^2 + b^2 + c^2$$

as the last vertical, *i. e.*

$$0 \quad 0 \quad 0 \quad 1$$

Further border now with

$$a\frac{d\xi}{dx} + \ldots,\ a\frac{d\eta}{dx} + \ldots,\ a\frac{d\zeta}{dx} + \ldots,\ 1.$$

This last determinant then breaks up into the product of two determinants. The first of the two is V bordered by 1 0 0 0 horizontally and 1 0 0 0 vertically. The final result is readily found to be

$$\frac{d\Sigma}{dS} = \frac{V'}{V} = \begin{vmatrix} \alpha & \frac{d\xi}{dx} & \frac{d\xi}{dy} & \frac{d\xi}{dz} \\ \beta & \frac{d\eta}{dx} & \frac{d\eta}{dy} & \frac{d\eta}{dz} \\ \gamma & \frac{d\zeta}{dx} & \frac{d\zeta}{dy} & \frac{d\zeta}{dz} \\ 0 & a & b & c \end{vmatrix}$$

By writing $\alpha, \beta, \gamma = a, b, c = \xi, \eta, \zeta$ we have at once Gauss's expression for the measure of curvature expressed as a determinant of the fourth order.*

Note on Partitions, by O. H. MITCHELL.

If the number of ways of dividing an integer w into j or fewer parts, none greater than i, be denoted by the symbol $(w : i, j)$, and if

$$\phi_j(w) = w - E\left(\frac{w + j - 1}{j}\right) = E\left(\frac{(j-1)w}{j}\right),$$

where E means "the number of integers in," then

$$(w : i, j) = \sum_{x = w - i}^{x = \phi_j(w)} (x : w - x, j - 1);$$

by a successive application of this formula j may be reduced to unity, whence

$$(w : i, j) = \sum_{x_1 = w - i}^{x_1 = \phi_j(w)} \ \sum_{x_2 = 2x_1 - w_1}^{x_2 = \phi_{j-1}(x_1)} \ \sum_{x_3 = 2x_2 - x_1}^{x_3 = \phi_{j-2}(x_2)} \ldots\ldots \sum_{x_{j-1} = 2x_{j-2} - x_{j-3}}^{x_{j-1} = \phi_2(x_{j-2})} \quad (1).$$

This is written symbolically for what the expression would become if the last sign of summation were replaced by $1 + \phi_2(x_{j-2}) - [2x_{j-2} - x_{j-3}]$, the range of its variable. The last two signs of summation may be replaced by

$$\tfrac{1}{2}\left\{\phi_2[2x_{j-3} - x_{j-4} + \varepsilon] + \phi_2\phi_3(x_{j-3}) + 2\right\}\left\{\phi_3(x_{j-3}) - [2x_{j-3} - x_{j-4}] + 1 - \varepsilon\right\} + \varepsilon\left\{\phi_2[2x_{j-3} - x_{j-4}] + 1\right\} - \left\{3x_{j-3} - 2x_{j-4} + \phi_2[2x_{j-4} - 3x_{j-3} + 2] + \phi_3(x_{j-3}) - [2x_{j-3} - x_{j-4}]\right\}\left\{1 + \phi_3(x_{j-3}) - [2x_{j-3} - x_{j-4}] - \phi_2[2x_{j-4} - 3x_{j-3} + 2]\right\},$$

where ε is the residue, modulus 2, of $\phi_3(x_{j-3}) - [2x_{j-3} - x_{j-4}] + 1$, and where negative values of the quantities inclosed in [ ] are to be neglected.

As a special case of the above

$$(w : i, 3) = \tfrac{1}{2}\left\{\phi_2(w - i + \varepsilon) + \phi_2\phi_3(w) + 2\right\}\left\{\phi_3(w) - w + i + 1 - \varepsilon\right\} + \varepsilon\left\{\phi_2(w - i) + 1\right\} - \left\{\phi_3(w) - i + \phi_2[2i - w + 2]\right\}\left\{\phi_3(w) - w + i + 1 - \phi_2[2i - w + 2]\right\},$$

where ε = residue mod. 2 of $\phi_3(w) - w + i + 1$.

Thus $(100 : 85, 3) = \tfrac{1}{2}\left\{7 + 33 + 2\right\}\left\{66 - 14\right\} - \left\{66 - 85 + 36\right\}\left\{66 - 14 - 36\right\} = 42.26 - 17.16 = 820.$

By use of the formula it is easy to obtain Prof. Sylvester's formula* for $(w : i, j) - (w - 1 : i, j)$ in terms of partitions of lower orders, viz.:

$$(w : i, j) - (w - 1 : i, j) = \sum_{\delta = 0}^{\delta = \phi_j(w) - [w - i]} (w - 2i + 2\delta : i - \delta, j - 2) - (w - i - 1 : i, j - 1).$$

March meeting.

On the Geometrical Representation of an Equation between Two Variables, by PROFESSOR CAYLEY.

An equation between two variables cannot be represented in a satisfactory manner by a curve, for this serves only to represent the corresponding *real* values of the variables: to represent the imaginary values the natural course is to represent each variable by a point in a plane, viz: the variable $z, = x + iy$, will be represented by a point the coordinates of which are the components x and y of the variable, and similarly the variable $z', = x' + iy'$, by a point the coordinates of which are the components x', y' of the variable: the equation between the two variables then establishes a correspondence between the two variable points, or say a correspondence between the planes which contain the two points respectively: and it is this correspondence of two planes which is the proper geometrical representation of the equation between the two variables: to exhibit the correspondence we may in either of the planes draw a network of curves at pleasure, and then draw in the other plane the network of corresponding curves. This well known theory was illustrated for the case $z' = \sqrt{z^4 - 1}$; taking in the infinite half-plane $y = +$ about the origin as centre a system of semicircles, to these correspond in the infinite plane of $x'y'$ a series of lemniscate-shaped curves: and by means of these it is easy to show in the second plane the path corresponding to a given path of the point $z, = x + iy$, in the first half-plane.

On the Properties of a Split Matrix, by J. J. SYLVESTER.

Suppose a square matrix split into two sets of lines which need not be contiguous and may be called ranges, say *ABC*, *DEFG*. Let the sum of the products of the corresponding elements of any two lines be called their product. It is well known (see Salmon's Higher Alg., 3d Ed., p. 82) that if the product of each line in the first range by every line in the other is zero, the opposite complete minors of the two ranges will be in a constant ratio, say in the ratio $l : \lambda$. Call the content of the matrix Δ: then it follows, if S, Σ denote the sums of the squares of the complete minors in the two ranges respectively, that

$$\frac{\lambda}{l} S = \frac{l}{\lambda}\Sigma = \Delta.$$

But by a theorem of Cauchy concerning rectangular matrices S is equal to the determinant $(A, B, C)^2$, *i. e.* to the determinant

$$\begin{matrix} AA & AB & AC \\ BA & BB & BC \\ CA & CB & CC \end{matrix}$$

and similarly $\quad \Sigma = (D, E, F, G)^2$

so that $\quad \lambda^2 : l^2 :: (D, E, F, G)^2 : (A, B, C)^2$

and $\quad S\Sigma = \Delta^2$.

Suppose now that the product of *every* two lines in the entire matrix is zero. Then into whatever two ranges the matrix be divided the ratio

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*Some weeks after the above note had been read I discovered that the Theorem had been announced, without proof, by Neumann, in Vol. XI of the *Mathematische Annalen*. T. C.

*See *Messenger of Mathematics*, May, 1878.

$\lambda^2 : l^2$ (since all but the diagonal terms in the matrices which express the ratio $l^2 : \lambda^2$ vanish) will be expressed by the ratio of one simple product to another: thus *ex. gr.* for the ranges $ABC : DEFG$
$\lambda^2 : l^2 :: D^2.E^2.F^2.G^2 : A^2.B^2.C^2$; also $\Delta^2 = A^2.B^2.C^2.D^2.E^2.F^2.G^2$.

If we now further suppose that the sum of the squares of the elements in each line is unity, *i. e.* that $A^2 = B^2 = C^2 = D^2 = E^2 = F^2 = G^2 = 1$, it will follow that every minor whatever divided by its opposite will be equal to Δ (for on the hypothesis made, $\frac{\lambda}{l} = \frac{\Delta}{S} = \Delta$).

Also Δ will be plus or minus unity since $\Delta^2 = 1$. Thus it is seen that we may pass by a natural transition from the theory of a split to that of an orthogonal or self-reciprocal matrix—to show which was the principal motive to the present communication. It is by aid of the theorem of the *split matrix* that I prove a remarkable theorem in Multiple Algebra, viz: that if the product of two matrices of the same order is a complete null, the sum of the nullities of the two factors must be at least equal to the order of the matrix—the nullity of a matrix of the order ω being regarded as unity, when its determinant simply is zero, as 2 when each first minor simply is zero, as 3 when each second minor is zero . . . as $(\omega - 1)$ when each quadratic minor is zero and as ω (or absolute) when every element is zero. This theorem again is included in the more general and precise one following—*If any number of matrices of the same order be multiplied together, the nullity of their product is not less than the nullity of any single factor and not greater than the sum of the nullities of all the several factors.*

In Prof. Cayley's memoir on Matrices (Phil. Trans., 1858) the very important proposition is stated that if

$$\begin{matrix} a & b & c & d \\ a' & b' & c' & d' \\ a'' & b'' & c'' & d'' \\ a''' & b''' & c''' & d''' \end{matrix}$$

be any matrix of substitution, say m (here taken by way of illustration of the order 4) the determinant $\begin{vmatrix} a-m & b & c & d \\ a' & b'-m & c' & d' \\ a'' & b'' & c''-m & d'' \\ a''' & b''' & c''' & d'''-m \end{vmatrix}$ is identically zero; or in other words, its nullity is complete. By means of the above theorem it may be shown that the nullity of any i distinct algebraical factors of such matrix is equal to i, i having any value from unity up to the number which expresses the order of the matrix, inclusive.

Note on the Non-Euclidean Trigonometry, by W. E. STORY.

Using Dr. Klein's generalization of Prof. Cayley's projective measurement, it is proved that the formulae of spherical trigonometry apply also to any non-Euclidean space of two dimensions, provided that angles and sides (lines) are replaced by certain constant multiples of them. The deduction will be given in detail in the *American Journal of Mathematics.*

Note on Partitions, by G. S. ELY.

A table of partitions may be constructed in the following manner. Fill the first line and the first two columns of a rectangle with 1's, and any other element is obtained in this way. For the i^{th} element in the j^{th} column, add to the $(i-1)^{th}$ element in the j^{th} column the i^{th} element in the $(j-i)^{th}$ column. Thus we get the table

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8
3	1	1	2	3	4	5	7	8	10	12	14	16	19	21	24	27
4	1	1	2	3	5	6	9	11	15	18	23	27	34	39	47	54
5	1	1	2	3	5	7	10	13	18	23	30	37	47	57	70	84
6	1	1	2	3	5	7	11	14	20	26	35	44	58	71	90	110
7	1	1	2	3	5	7	11	15	21	28	38	49	65	82	105	131

Number the columns commencing with 0 and the lines commencing with 1. This is the same table Euler gave in the Com. Arith. Coll., Vol. I, p. 97, and is of course capable of indefinite extension. Euler constructed his table by lines instead of by columns, and he shows that the number of partitions of w things into j or fewer parts, $(w: w, j)$, is given by the number in the line j and column w. Thus $(12: 12, 7) = 65$. The value of the symbol $(w: i, j)$, *i. e.* the number of partitions of w things into j parts, none of which shall be greater than i, can also be found from the table in the majority of cases, viz: when the greater of i and j is $\geqq \frac{w-4}{2}$, by the following rule: suppose $i \geqq j$, for if not it only needs to be remembered that $(w: i, j) = (w: j, i)$. Then to find the value of $(w: i, j)$, subtract from the value of $(w: w, j)$ as given by the table the sum of the first $(w - i)$ elements in the $(j-1)^{th}$ line and add to it 0, 1 or 2 according as $i \geqq \frac{w-2}{2}$, $= \frac{w-3}{2}$ or $= \frac{w-4}{2}$. Thus the value of $(14: 9, 7)$ is $105 - (1+1+2+3+5) + 0 = 93$; or again $(15: 6, 6) = 110 - (1+1+2+3+5+7+10+13+18) + 1 = 51$.

The proportion of the number of times this rule gives the value of $(w: i, j)$ is $\frac{3}{4}$ when w is indefinitely large. But for ordinary values of w it is much larger. Thus out of the 275 possible expressions when $w \leqq 12$ all are given by this rule: of the 530 expressions when $w \leqq 15$ all are given except the following six $(13: 4, 4)$, $(14: 4, 4)$, $(15: 3, 5)$, $(15: 4, 4)$, $(15: 4, 5)$ and $(15: 5, 5)$ which are readily seen to be equal respectively to 3, 2, 1, 1, 6 and 13. And generally those expressions not given by this rule are the easiest to calculate by the ordinary mechanical means.

These formulae were also obtained. If $N =$ the whole number of expressions for any particular value of w,

$$N = \frac{w^2 - 2w + 6}{2} - \sum_{n=2}^{n=\infty} E\left(\frac{w - (n^2 + n + 1)}{n+1}\right) \text{ if } w \text{ is even, and}$$

$$N = \frac{w^2 - 2w + 5}{2} - \sum_{n=2}^{n=\infty} E\left(\frac{w - (n^2 + n + 1)}{n+1}\right) \text{ if } w \text{ is odd.}$$

$E(x)$ signifying the greatest integer in x, positive values of $E(x)$ only being taken into account. Thus if $w = 100$ we readily find that $N = 4809$.

Finally this value for ΣN was obtained, for w even

$$\sum_{w=1}^{w=n} N = \frac{2n^3 - 3n^2 + 28n - 24}{12} - \frac{1}{2} \sum_{i=3}^{i=\infty} (ia_i(a_i - 1) + 2a_i\phi_i n)$$

and for w odd

$$\sum_{w=1}^{w=n} N = \frac{2n^3 - 3n^2 + 28n - 27}{12} - \frac{1}{2} \sum_{i=3}^{i=\infty} (ia_i(a_i - 1) + 2a_i\phi_i n)$$

where $a_i = E\left(\frac{n - i^2 + i - 1}{i}\right)$, only positive values being taken into account, and $\phi_i n = n - iE\left(\frac{n-1}{i}\right)$, that is $\phi_i n$ is the excess of n over the greatest multiple of i which is less than n. Thus as an example, if $n = 25$

$$a_3 = E\left(\frac{25-7}{3}\right) = 6,\ a_4 = E\left(\frac{25-13}{4}\right) = 3,\ a_5 = E\left(\frac{25-21}{5}\right) = 0,$$

$\phi_3 25 = 1$, $\phi_4 25 = 1$, $\phi_5 25 = 5$. Substituting we have $\sum_{w=1}^{w=25} N = 2488$.

April meeting.

On Associative Imaginaries, by PROF. CAYLEY.

The imaginaries (x, y) defined by the equations

$$\begin{aligned} x^2 &= ax + by \\ xy &= cx + dy \\ yx &= ex + fy \\ y^2 &= gx + hy \end{aligned}$$

will not be in general associative: to make them so, we must have 8 double relations corresponding to the combinations x^3, x^2y, xyx, xy^2, yx^2, yxy, y^2x, y^3 respectively, viz: the first of these gives $x.x^2 - x^2.x = 0$, that is $0 = x(ax + by) - (ax + by)x, = b(yx - xy), = b[(e-c)x + (f-d)y]$; that is $0 = b(e-c)$ and $0 = b(f-d)$: and similarly for each of the other terms: we thus obtain apparently 16, but really only 12 relations between the 8 coefficients a, b, c, d, e, f, g, h, viz: the relations so obtained are
$b(c-e) = 0$ (twice), $b(f-d) = 0$, $g(c-e) = 0$, $g(f-d) = 0$ (twice),
$bg - ed = 0$ (twice), $bg - ef = 0$ (twice),
$c^2 + dg - ag - ch = 0$, $d^2 + bc - ad - bh = 0$, $e^2 + fg - ag - eh = 0$,
$f^2 + be - af - bh = 0$,
$a(c-e) - cf + de = 0$, $h(f-d) - cf + de = 0$.

From the first four equations it appears that either $b = 0$ and $g = 0$ or else $c = e$ and $d = f$: for brevity I attend only to the latter case, giving the commutative system

$$\begin{aligned} x^2 &= ax + by, \\ xy = yx &= cx + dy, \\ y^2 &= gx + hy; \end{aligned}$$

in order that this may be associative, we must still have the relations

$$\begin{aligned} bg &= cd, \\ c^2 + dg - ag - ch &= 0, \\ d^2 + bc - ad - bh &= 0, \end{aligned}$$

which are all three of them satisfied by $g = \frac{cd}{b}$, $h = \frac{d^2 + bc - ad}{b}$, viz: we thus have the associative and commutative system

$$\begin{aligned} x^2 &= ax + by, \\ xy = yx &= cx + dy, \\ y^2 &= \frac{cd}{b}x + \frac{d^2 + bc - ad}{b}y. \end{aligned}$$

I did not perceive how to identify this system with any of the double algebras of B. Peirce's Linear Associative Algebra, see pp. 120-122 of the Reprint, *American Journal of Mathematics*, t. IV (1881); but it has been pointed out to me by Mr. C. S. Peirce, that my system in the general case $ad - bc$ not $= 0$, is expressible as a mixture of two algebras of the form (a_1), see p. 120; whereas if $ad - bc = 0$, it is reducible to the form (c_2), see p. 122. The object of the present Note is to exhibit in the simple case of two imaginaries the whole system of relations which must subsist between the coefficients in order that the imaginaries may be associative; that is the system of equations which are solved implicitly by the establishment of the several multiplication tables of the memoir just referred to.

Note on Singular Solutions, by H. M. Perry.

The differential equation of the first order and degree for which $u = 0$ is a singular solution, may always be written,

$$y' = \phi_1 + y'_u,$$

where y'_u is the value of y' derived from $u = 0$, and ϕ_1 is a function of x and u which vanishes when $u = 0$.

The differential equation of the second order becomes after substituting $y' = \phi_1 + y'_u$, $u = 0$,

$$y'' = \frac{\partial \phi_1}{\partial u} \frac{\partial u}{\partial y} \phi_1 + y''_u = \phi_2 + y''_u;$$

similarly, if $\phi_2 = 0$ when $u = 0$,

$$y''' = \frac{\partial \phi_2}{\partial u} \frac{\partial u}{\partial y} \phi_1 + y'''_u = \phi_3 + y'''_u,$$

and in general if $\phi_1, \phi_2, \ldots \phi_{r-1} = 0$ when $u = 0$,

$$y^r = \frac{\partial \phi_{r-1}}{\partial u} \frac{\partial u}{\partial y} \phi_1 + y^r_u.$$

Hence the following results are easily deduced:

If n is the least power to which u occurs in ϕ_1, $u = 0$ is a singular solution for differential equations of all orders less than $\frac{1}{1-n}$.

If $\frac{1}{1-n}$ lies between two integers r and $r+1$, $u = 0$ satisfies the rth differential equation and makes the $(r+1)$th and all higher derivatives infinite.

If $\frac{1}{1-n}$ is negative, $u = 0$ satisfies all differential equations.

If $0 < n < \frac{1}{2}$, $u = 0$ is the equation of a curve tangent to the curves of the complete primitive at their cusps.

On Cubic Curves, by F. Franklin.

The investigation in this paper was based upon a consideration of the mixed polars of a pair of points with respect to the system of cubics represented by the equation $x^3 + y^3 + z^3 + 6lxyz = 0$; by this means a number of known properties of cubics were very simply and consecutively obtained, together with some properties believed to be new. The communication will be made the basis of a paper in a forthcoming number of the *American Journal of Mathematics*.

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

Published here.

American Journal of Philology. Edited by Professor Gildersleeve. *Vol. II. No.* 8. 1881.

Article I.—On the Fragments of Sophocles. By Robinson Ellis.

In this paper Professor Ellis has emended and illustrated some thirty odd fragments of Sophocles with especial reference to Professor Campbell's recent edition.

Article II.—Virgil's instructions for Ploughing, Fallowing, and the Rotation of Crops. By Clement L. Smith.

Professor Smith combats the view accepted by Heyne and by most recent editors of the Georgics, that the first of Virgil's four ploughings (Georg. I, 48) falls in the autumn, a whole year before seed-time. The autumn ploughing—for the sake of which Wagner assumes that vv. 47–49 could have been no part of the original poem—seems to Professor Smith purely imaginary, and from an examination of the Roman prose writers on husbandry the conclusion is reached that Virgil's four ploughings are: (1) in early spring, (2) in April, to kill the weeds, (3) in summer, (4) in the autumn just before sowing. In the matter of fallowing and rotation of crops Virgil's instructions are quite consistent with Varro's rule for fallowing in alternate years and with the two year system, which the modest dimensions of the ordinary Italian farm probably made very general. Yet he chooses to leave his language (Georg. I, 71–83) vague and it applies as well to a three year system as to any system which secures for the land the relaxation it needs, by relieving it 'every other time' from the burden of bearing the heavy grain crop. The difficulty which arises from the incongruity of Virgil's presentation of the advantages of rotation over fallowing, it is proposed to remove by transposing vv. 82, 83, and putting them immediately after 76. In this way we should have first a presentation of two ways of relieving the exhausted land, (vv. 71–76) with a statement of the advantage of the second over the first, (82 f.) then would come the reason why such relief is needed, (77 f.) and from that a skilful transition to the subject of manuring.

Article III.—The Semitic vowel a. By C. H. Toy.

In this article Professor Toy has gathered some materials for the history of the first Semitic vowel *a*, giving first the cases in which it has maintained itself, and then the changes it has undergone. So it is preserved in the primitive or underived nouns, in the monosyllabic triliterals of all the dialects, in dissyllabic triliterals of most—the Arabic being the richest. So in certain derived nouns, in the original form of the perfect of the verb, and in certain pronominal forms and most simple particles. It has been degraded into—1. *ă*, *ĕ*. 2. Into *i*. It has been shortened, it has been reduced to a sh'wa, it has disappeared. Then again it has been broadened into *ā*, diphthongized into *ê*, and finally subjected to sporadic modifications in the Hebrew *Hiphil*. There has thus been, from the earliest known times, a very considerable movement of this vowel, which closely resembles vowel modification, in other families of languages, particularly the European, and so far points to the oneness of the phonetic principles that control the various groups of human speech.

Article IV.—On the position of Rhematic to. By H. E. Shepherd.

The insertion of an adverb between *to* and the infinitive has been noted in a number of reputable writers. Dr. Fitzedward Hall has discovered this peculiarity in at least a score of well-known authors, extending from Chaucer and Wickliffe to George Eliot and Mr. Ruskin. The author who most abounds in this use is Bishop Pecock, the author of the "Repressor" (A. D. 1456), and Professor Shepherd has culled from this work a number of phrases which illustrate almost every feature of his usage, and has noted a number of examples from reputable authors, English and American, among them some of our most accomplished essayists and philologists.

Article V.—Assyriological Notes. By J. F. McCurdy.

These notes refer to כשר, קשר, and ברה

Article VI.—On πρίν in the Attic Orators. By the Editor.

πρίν is a comparative formation. From this follows its negative sense (*before = not yet.*) The negative sense carries with it the prevalent use of the aorist tense. This principle has not been clearly formulated in the text books of Greek grammar, although the fact has sometimes been emphasized. There is no exception worth considering to the rule that in classic Greek *πρὶν ἀν* with subj. and *πρίν* with opt. require a negative in the lead. Exceptions sometimes cited are no exceptions; the negative sense has escaped those who have adduced the examples. One real exception must be emended out of existence. On the other hand, *πρίν* with the indicative may follow a positive clause, but many of the positive clauses cited are really negative, and even when a positive clause is used, the context must show the equivalency of *πρίν before* to *ἕως until.* After this criticism on the ordinary presentation, the author of the paper proceeds to show briefly the history of the usage. The dominant construction in the entire period is *πρίν* with the aorist infinitive, an anomalous combination. The various theories as to the origin of this construction are briefly discussed, and this discussion is followed by the statistics of the oratorical usage of *πρίν*, with a presentation of the normal Greek usage under each head. Exceptions are treated at greater or less length. In the orators, as might have been expected, a certain crystallization is noticeable. Of individual peculiarities there is not much to say. Demosthenes uses the particle simply; Isokrates in his more formal orations employs *πρότερον-πρίν* freely for the sake of balance; Lysias is sharp and masculine.

There are three elaborate *Reviews*, one of Storm's *Englische Philologie* by Professor **Garnett**, one of the works of *Spyridon Lambros* by Mr. **Thomas Davidson**, and one of Gustav Meyer's *Griechische Grammatik* by Dr. **Bloomfield**, in which the reviewer has introduced a *Note on the Theory of Sonant Coefficients.* Professor **Lanman** has noticed with some detail Peile's *Tale of Nala.* The other reviews concern Mezger's *Pindar's Siegeslieder*, Arnoldt's *Chor im Agamemnon des Aeschylus*, Seuffert's *Deutsche Literaturdenkmale*, and Otis's *Elementary German.*

Reports are made of the *Rheinisches Museum*, *Fleckeisen's Jahrbücher*, *Philologus*, Kölbing's *Englische Studien.*

In the *Correspondence* there is a letter from Mr. A. S. **Cook** on *The Philological Society's English Dictionary.*

The management of the journal at the close of this, the second volume, offers to new subscribers the two back volumes for $2.00 a volume, payable in advance.

No. 9, which is the opening number of Vol. III of the *Journal of Philology*, is in press and contains:

Articles on *Nonius Marcellinus*, by Professor **Nettleship**; on the *Insertion of an adverb between* TO *and the Infinitive*, by Dr. **Fitzedward Hall**; on *Final* AS *in Sanskrit*, by Dr. **Maurice Bloomfield**; on the *Phonetics of the Ormulum*, by Mr. **Blackburn**; on the *MSS. of Terence*, by Dr. **Warren**; on "*For-Sake*," by Professor **Garnett**.

Reviews and Notes of Deffner's *Zakonische Grammatik*, *Anecdota Oxoniensa*, MacMahon's *Translation of Brédif's Demosthenes*, Campbell's *Sophocles*, Ellis's *Ibis*, Hayman's *Odyssey*, *Transactions of Cambridge Philological Society*, *Recent Publications in Norse Philology.*

Reports of *Hermes*, *Mnemosyne*, *Anglia*, *Romania*, *Journal de Philologie.*

Correspondence (letters from L. **Campbell**, L. R. **Packard**, A. D. **Savage**).

Studies from the Johns Hopkins Biological Laboratory. Edited by Professor Martin. *Vol. II. No.* 2.

Article I.—List of Medusæ found at Beaufort, N. C., during the Summers of 1880 *and* 1881. By W. K. Brooks.

During the two summers forty-three species were found; twenty-seven of these had previously been described by A. Agassiz and McCrady as occurring at Charleston, S. C. Eight of the species found were entirely new to science.

Article II.—On the Origin of the so-called "Test-Cells" in the Ascidian Ovum. By J. Playfair McMurrich. With plate.

The author worked last summer at the marine zoölogical station of the University, using the eggs of two species. He comes to the conclusion that the "test-cells" are simply masses of albuminous matter containing two or three granules of food-yolk, and originate by separation of bits of egg protoplasm forced out during its contraction. The meaning of the process cannot be elucidated until we know the life-histories of more of the lower Ascidia.

Article III.—A Contribution to the study of the Bacterial Organisms commonly found upon exposed Mucous Surfaces and in the Alimentary Canal of healthy persons. By George M. Sternberg, Surgeon U. S. A. With three heliotype plates from micro-photographs.

The author describes the bacteria found in the mouth, and near the openings of other cavities of the body; and gives an account of the results of their culture outside the body in various nutritive media. The object of the paper is to contribute to a knowledge of what harmless varieties exist in the healthy body, with reference to the now generally accepted doctrine that some forms of bacteria when living in the body cause serious diseases.

Article IV.—A Fatal Form of Septicæmia in the Rabbit produced by the subcutaneous injection of Human Saliva. By George M. Sternberg, Surgeon U. S. A. With one heliotype plate.

The author's saliva contains a micrococcus which causes it to kill rabbits with all the symptoms of septicæmia within twenty-four hours. The subcutaneous areolar tissue of rabbits dying from this is found infiltrated with bloody serum and swarming with micrococci. These can be artificially cultivated in *bouillon* made from the flesh of a healthy rabbit; and a small drop of the sixth generation of the artificial culture possesses all the virulence of the original specimen.

Article V.—Experiments with Disinfectants. By George M. Sternberg, Surgeon U. S. A.

Taking the infected *bouillon* referred to above, the author added to it various percentages of different reputed disinfecting agents, and then injected it into rabbits, with the object of seeing if the virulence of the micrococcus had been destroyed.

As a result he puts the disinfectant in three groups. (1) Those efficient in proportion of 0.5 per cent. or less. Among them are iodine, chromic acid, thymol, ferric chloride, sodium hyposulphite, &c., &c. (2) Those inefficient when present in not larger proportion than 0.5 per cent. but efficient in proportion under 2 per cent. In this group, with others, are included carbolic acid, salicylate of soda, zinc chloride, potassium permanganate, and borax. (3) Substances which fail to disinfect when present in the proportion of 2 per cent. In this class we find glycerine, alcohol, pyrogallic acid, alum, &c., &c.

Article VI.—Observations on the Direct Influence of Variations of Arterial Pressure upon the Rate of Beat of the Mammalian Heart. By H. Newell Martin.

The experiments were made upon dogs, whose hearts were completely isolated physiologically from all the rest of the body, except the lungs. The heart was supplied with defibrinated blood of a constant temperature, supplied to the right auricle from a Marriotte's flask, and therefore under constant pressure. The result arrived at was that variations of aortic pressure, between 25 and 140 millimetres of mercury, had no influence whatever upon the pulse rate.

Article VII.—The Influence of Variations of Arterial Pressure upon the Pulse Rate in the Frog and the Terrapin. By Wm. H. Howell and Mactier Warfield. With one plate.

The method employed and the results obtained were essentially the same as those described in connection with Article VI. (See p. 208.)

Article VIII.—Some Notes on the Development of Arbacia punctulata. By H. Garman and B. P. Colton. With two plates.

The eggs were artificially fertilised, and their development followed until the young sea-urchins emerged from the plutei. The authors describe in detail the structure and habits of the pluteus in its various stages; and also the structure of the young sea-urchin.

Article IX.—On the Structure and Significance of some Aberrant forms of Lamellibranchiate Gills. By K. Mitsukuri.

The species studied were Nucula proxima and Yoldia limatula. The gills in these species are extremely simple, and the results of their study, combined with those of other workers on more complex forms, make it tolerably certain that the primitive Lamellibranchiate gill was filamentary.

Article X.—Observations on the Early Stages of some Polychætous Annelides. By Edmund B. Wilson. With four plates.

This article contains descriptions and figures of the early stages of five genera of Annelides, viz: *Clymenella*, *Arenicola*, *Chætopterus*, *Spiochætopterus*, and *Diopatra*. It is shown that the segmentation of the egg is, in its earlier stages, of the same type with some *Oligochæta*, *Hirudinea*, *Gephyrea*, *Mollusca*, *Turbellaria*, etc, the egg dividing into two, four, and then into eight spherules, of which four are ectodermic and four mainly entodermic. In later stages there are indications of a process which shows some similarity to delamination and suggests the way in which the latter mode of development may have been derived from epibolic invagination.

The larvæ of *Clymenella* and *Arenicola* are shown to be *Telotrochæ*, which have probably been modified by the larvæ having abandoned a free-swimming life. The young *Diopatra* is an "Atrocha," but shows indications of having been derived from a Telatrochous form. *Chætopterus* and *Spiochætopterus* are typical Mesotrochæ; the latter is permanently monotrochal, the latter only in its earlier stages. In *Chætopterus* a provisional belt of cilia appears, which is replaced afterwards by a permanent belt behind it.

Article XI.—The Origin of the Eggs of Salpa. By W. K. Brooks. With one plate.

In this paper the author brings forward new facts which support a view formerly promulgated by him, in accordance with which each salpa of a chain is a male, which before its separation from the body of the solitary salpa, receives one egg from it. (See p. 202).

No. 3 of Volume II. of *Studies from Biological Laboratory* is in press, and contains:

Article I.—Observations on the Blood-flow in the Coronary Arteries of the Heart. By H. N. Martin and Wm. T. Sedgwick.

Article II.—The Influence of Digitaline upon the Work of the Heart. By H. H. Donaldson and M. Warfield.

Article III.—On a New Species of Pilidium. By E. B. Wilson.

Article IV.—Observations on Blood Pressure and Pulse in a Case of Open Ductus Arteriosus in a Dog. By Wm. H. Howell and Frank Donaldson.

Article V.—On the Polar Effects of Weak Induction Currents. By H. Sewall.

Article VI.—On the Development of Starch Granules. By A. F. W. Schimper.

American Journal of Mathematics. Edited by Professor Sylvester. *Vol. IV. Nos.* 2 and 3.

Article I.—Linear Associative Algebra. By the late Benjamin Peirce. With Notes and Addenda, by C. S. Peirce, son of the author.

The consent of the family of the late Professor Benjamin Peirce has been kindly given to the publication in the *American Journal of Mathematics*, of his valuable and unique memoir on Linear Associative Algebra, of which only a small number of copies in lithograph were taken in the author's lifetime, for distribution among his friends. This publication will, it is believed, supply a want which has been long and widely felt, and bring within the reach of the general mathematical public a work which may almost be entitled to take rank as the *Principia* of the philosophical study of the laws of algebraical operation. The text has been revised and annotated by Mr. C. S. Peirce; in his foot-notes will be found, besides other matter, expressions for the units of the various algebras in terms of the algebra of relatives. The *Addenda* are as follows:

I. On the Uses and Transformations of Linear Algebra. By Benjamin Peirce. (Presented to the American Academy of Arts and Sciences, May 11, 1875.)

II. On the Relative Forms of the Algebras. By C. S. Peirce.

III. On the Algebras in which Division is Unambiguous. By C. S. Peirce.

This paper occupies the whole of No. 2, and more than one third of No. 3, of the Journal.

Article II.—On Tchebycheff's Theory of the Totality of the Prime Numbers comprised within given Limits. By J. J. Sylvester.

If it be admitted that Legendre's approximate formula for the number of prime numbers inferior to a given number, which has been confirmed by direct enumeration of the number of prime numbers contained in the first few millions, can be extended to those remote regions of number which transcend the limits and even the possibilities of human experience, it will follow as a consequence that the average density of the distribution of prime numbers in the neighborhood of a large quantity x approximates to $\frac{1}{\log x}$, and consequently that the number of primes included between x and $(1+\varepsilon)\,x$, or if we like to say so, between $x+A$ and $(1+\varepsilon)x+B$, will be approximately equal to $\frac{\varepsilon x}{\log x}$, and therefore will become indefinitely great, however small ε may be taken. Although there can hardly be a doubt that such is the fact, no step had been taken previous to Tchebycheff's researches towards establishing this proposition demonstratively. Tchebycheff has succeeded in proving it, not, it is true, in an absolute sense, but for all values of ε exceeding the fraction $\frac{1}{5}$. He has done more, inasmuch as he has given formulae for actually ascertaining a number x for all values superior to which there will be at least any specified number K of primes included between $x+A$ and $(1+\varepsilon)\,x+B$ when ε has any positive value superior to $\frac{1}{5}$, and A and B are any quantities positive or negative. The object of what follows is to make a further advance in the same direction, and to show upon Tchebycheff's own principles that the proposition remains true when ε is conditioned no longer to be inferior to the fraction $\frac{1}{5}$, but to the fraction $\frac{1}{6}+\frac{1}{4642\frac{10}{11}}$, so that the excess above unity (the region, so to say, of darkness) is reduced to scarcely more than five-sixths of its value for the first named fraction. This conclusion is arrived at by aid exclusively of Tchebycheff's own formulae.

Tchebycheff's method may be regarded as the *first* approximation to the inferior and superior limits of a quantity ψx subject to the conditions

$$Vx > Ax + F\log x,$$

$$Vx < Ax + F_1 \log x,$$

where $Vx = \psi x - \psi\frac{x}{6} + \psi\frac{x}{7} - \psi\frac{x}{10}$ etc., (see Serret's *Cours d'Algèbre supérieure*, 4th Ed., Vol. 2, pp. 230–238). and to the further conditions that ψx is not less than $\psi x'$ if $x > x'$, and that $\psi x = 0$ when $x < 1$.

The limits obtained for ψx depend exclusively on these definitions, and would be applicable to any function ψx whatever that satisfied them.

The advance made in this article consists in pursuing the approximation through an indefinite number of steps, in each of which use is made of the limits attained in the preceding one, so as to bring the superior and inferior limits to ψx continually nearer and nearer to each other as regards the *principal* term (a multiple of x) which enters into each of them: the remaining terms over and above this multiple of x in the expressions for the limits always continue to be positive-integer powers of $\log x$, and consequently the ratio of the limits becomes as nearly as we please identical with the ratio of the principal terms (*i. e.* of their coefficients) when x is taken sufficiently great: this ratio as given in the first approximation is $\frac{6}{5}$, but as the approximation is continued continually converges to but never reaches the fraction above referred to, viz: $\frac{7}{6}+\frac{1}{4642\frac{10}{11}}$.

Such, and such only, is the small but not unimportant contribution here supplied to Tchebycheff's remarkable theory. As no allusion is made to the possibility of this contraction of the limits in a work published so recently as 1879, by an author so competent as M. Serret, the writer presumes that it has hitherto remained unnoticed.

As a matter of fact, resting on evidence (although empirical in its character) leaving on the mind scarcely a shadow of doubt of the correctness of the conclusion to which it points, the true asymptotic value of $\frac{\psi x}{x}$ when ψx signifies the quantity so designated in M. Serret's article is unity. The mean value of the superior and inferior limits to this value given by the ordinary Tchebycheff formulæ is 1.01342 . . . ; the mean value given by the limits found in this article is .999697. . . . The deviation of the mean from the presumable true value of the ratio is accordingly less than .00303 in the one case and more than .01342 in the other, so that the effect of the seemingly slight change in the limits effected in this article is to give a result almost 45 times nearer to the truth than that given by the mean value of the limits previously determined. The article concludes with a demonstration that if by any method it should at any time be found possible to cause the superior and inferior limits of the asymptotic value of $\frac{\psi x}{x}$ to differ from each other by a quantity capable of being made indefinitely small, the quantity towards which these limits converge in opposite directions can be no other than *unity*.

Article III.—Specimen of a Literal Table for Binary Quantics, otherwise a Partition Table. By Professor Cayley.

"The table, commencing 1; b; c, b^2; d, bc, b^3; . . . is in fact a Partition Table, viz considering the letters b, c, d, . . . as denoting 1, 2, 3, . . . respectively, it is 1^0; 1; 2, 11; 3, 12, 111; . . . a table of the partitions of the numbers 0, 1, 2, 3, . . . , expressed however in the literal form, in order to its giving the literal terms which enter into the coefficients of any covariant of a binary quantic. The table ought to have been made and published many years ago, before the calculation of the covariants of the quintic; and the present publication of it is, in some measure, an anachronism: but I in fact felt the need of it in some calculations in regard to the sextic; and I think the table may be found useful on other occasions. I have contented myself with calculating the table up to $s = 18$, that is, so as to include in it all the partitions of 18: it would, I think, be desirable to extend it further, say to $z = 26$, or even beyond this point, but perhaps without introducing any new letters, (that is, so as for the the higher numbers to give only the partitions with a largest part not exceeding 26)."

The above is followed by remarks upon the employment of the table, and an explanation of the method used in its construction; the table itself occupies about four and one-half pages.

Article IV.—Note on Hansen's General Formulae for Perturbations. By G. W. HILL.

Hansen's expression for the perturbations of the mean anomaly is modified in such a way that it does not involve the element he denominates as h. In the second place, a formula is given for determining the residual perturbations of the radius vector, which does not require the performance of any integration additional to those already made in getting the perturbations of the mean anomaly. This formula is given in its rigorous form and also as simplified when either second or third order terms may be neglected. It is absolutely necessary to make use of this formula in getting the constant term of the second coördinate; and advantageous even for getting the portion which involves simply the powers of the time. Hansen has nowhere given explicitly this equation, although his analysis implicitly involves it.

Article V.—On the Solution of a certain class of Difference and Differential Equations. By J. J. SYLVESTER.

Very many years ago the writer of this paper fell upon a class of equations in finite differences, of which the *general solution* can be found. See the posthumous edition of Boole's Finite Differences, edited by Mr. Moulton, pp. 229-231.

The equation in question has the persymmetrical determinant

$$\begin{vmatrix} U_x, & U_{x+1} & \cdots\cdots & U_{x+i}, \\ U_{x+1}, & U_{x+2} & \cdots\cdots & U_{x+i+1}, \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ U_{x+i}, & U_{x+i+1} & \cdots\cdots & U_{x+2i} \end{vmatrix}$$

(i being any number), for its left hand and cm^x for its right-hand member. Instead of U_x, U_{x+1} .... U_{x+2i}, may be written $y, \frac{d}{dx}y, \ldots, \left(\frac{d}{dx}\right)^{2i} y$, and the corresponding differential equation will readily be seen to admit of an analogous solution. In the present article it is shown that leaving unaltered the left-hand member of the equation so formed (whether expressed in terms of U_x and its augmentatives, or of y and its derivatives) but writing, in the right-hand member, instead of the single exponential a linear function of $i+1$ exponentials, a *particular* solution of the equation so modified can be found for all values of i provided only that the exponentials in question m_1^x, $m_2^x, \ldots, m_i^x$ remain distinct from each other. In the case of any of these becoming equal (unless they all become so at once, in which case the original equation admitting of a known general solution comes back again) or what is the same thing in case of any of the coefficients of the linear functions vanishing, (unless they all but one vanish) the solution becomes illusory; but if instead of taking any group of the exponentials and making them absolutely equal, they be regarded as differing from each other by infinitesimal quantities, such group or each of several of such groups will be replaced by a rational integral function in x of an order inferior by unity to the number of coalescing exponentials in the group, multiplied by a single exponential; and the solution of the equation so modified may be elicited from the solution applicable to the general form of the equation. The cases of $i = 2$, $i = 3$, are worked out in full, and there would not be the slightest difficulty in obtaining analogous solutions for the differential equations $yy'' - y'^2 = Aa^x + Bb^x + Cc^x$, $yy''y'''' - yy'''^2 - y'^2y'''' + 2y'y''y''' - y''^3 = Aa^x + Bb^x + Cc^x + Dd^x$

Article VI.—On the Analytical Forms called Trees. By PROFESSOR CAYLEY.

This article contains a new formula, by generating functions, for the number of distinct trees of N knots; the formula being derived from the consideration of the centre or bicentre of number, instead of the centre or bicentre of length, which was the basis of the investigation previously given by the author, (*Brit. Assoc. Report*, 1875).

Articles VII, VIII, IX, X.—Notes.

1°. *On Symbols of Operation.* By PROFESSOR CROFTON.

2°. *On Segments made on Lines by Curves.* By MISS CHRISTINE LADD.

3°. *On the Multiplication of the $(n-1)^{th}$ power of a Symmetric Determinant of the n^{th} Order by the Second Power of any Determinant of the same Order.* By THOMAS MUIR.

4°. *On Newton's Method of Approximation.* By F. FRANKLIN.

Article XI.—Simple and Uniform Method of Obtaining Taylor's, Cayley's and Lagrange's Series. By J. C. GLASHAN.

Article XII.—Forms of Rolle's Theorem. By J. C. GLASHAN.

CONTENTS:—

I. *Functions of a Simple Variable.* 1. Fundamental Form (Rolle's). 2. Extension of Rolle's Form. 3. Lagrange's Form. 4. Cauchy's Form. 5. Special case of Cauchy's Form. 6. Extension of Cauchy's Form. 7. Forms expressed by definite integrals. 8. Remainder in Taylor's Theorem. 9. Remainder in Cayley's Theorem. 10. Remainder in Lagrange's Series.

II. *Functions of a Complex Variable.* 11. General Form. 12. Special Form. 13. Remainder in Taylor's Theorem.

This article covers about eleven pages, of which the last four will appear in No. 4 of the *Journal.*

American Chemical Journal. Edited by PROFESSOR REMSEN. Contents of *Vol. IV, No.* 2. May, 1882.

Article I.—On Certain Substances obtained from Turmeric.—Curcumin. By C. LORING JACKSON and A. E. MENKE.

Article II.—Dibromiodacrylic and Chlorbromiodacrylic Acids. By C. F. MABERY and RACHEL LLOYD.

Article III.—Preliminary Notice on Orthoiodbenzylbromide and its Derivatives. By C. F. MABERY and F. C. ROBINSON.

Article IV.—Chlortribrompropionic Acid. By C. F. MABERY and H. C. WEBER.

Article V.—Influence of Peptones and certain Inorganic Salts on the Diastatic Action of Saliva. By R. H. CHITTENDEN and J. S. ELY.

Article VI.—On the Determination of Reverted Phosphates. By THOMAS S. GLADDING.

Article VII.—Columbite and Orthite from Amelia County, Virginia. By F. P. DUNNINGTON.

Article VIII.—A New Mineral from Colorado. By F. W. CLARKE and N. W. PERRY.

Article IX.—Oxidation of Metatoluene-sulphamide. By IRA REMSEN and CHASE PALMER.

A Report on Progress in Agricultural Science. By H. P. ARMSBY.

Reviews of the Treatises on Organic Chemistry of Roscoe and Schorlemmer, and of Wislicenus. By THE EDITOR.

Notes: On a New Gas Regulator, Processes for Direct Coppering of Castings of Iron and Steel; Artificial Quinine.

Recent Publications.

MARYLAND HISTORICAL SOCIETY AND PEABODY INSTITUTE.

The following *Notes* are reprinted from *The Nation*, New York, March 16 and March 30, 1882.

Deposit of the Colonial Archives of the State with the Maryland Historical Society.

The colonial and revolutionary archives of Maryland are about to be transferred from the Land Office at Annapolis to the keeping of the Maryland Historical Society in Baltimore, in accordance with a bill lately passed by the Maryland Senate (March 16), and House of Delegates (March 12)—a bill which was the outgrowth of a memorial presented to the Legislature by the above Society, and already mentioned in these columns. These archives embrace the acts and resolves of the Province of Maryland; the council books of the Proprietary; the journals and correspondence of the Council of Safety; letters from Maryland delegates in the Continental Congress; sixty-two manuscript letters from George Washington; letters from Knox, Marion, Gates, Lincoln, Greene, Lee, Lafayette, Pulaski, Steuben, De Kalb, De Grasse, Rochambeau; and papers relating to the Maryland militia, which did such efficient service at the North under Smallwood, and at the South under John Eager Howard. While many valuable records of colonial and Revolutionary Maryland have been lost or damaged from lack of proper care, those which yet remain will be faithfully preserved by the Maryland Historical Society, whose library is already a treasure-house of Maryland laws, documents, manuscripts, family papers, pamphlets, broadsides, and newspaper files (covering the entire Revolutionary period, and extending as far back as 1728). For the safe keeping and easy consultation of the State papers and most valuable Society documents, a fire-proof room, adjoining the main part of the library, will probably be constructed, for members of the Society are now endeavoring to obtain funds for this purpose. The State has made an appropriation sufficient to begin the work of "arranging, editing, and publishing" the archives, together with "other documents pertaining to the history of Maryland." The State will be the owner of all volumes published by its aid, but the Society is empowered to sell these publications at cost price, and to add the proceeds to the State Publication Fund, simply reporting progress, receipts, and expenditures, from year to year, to the Legislature. Thus an undertaking which in the hands of politicians might perhaps have become a piece of printer's jobbery, as some States have found to their cost, is removed from all temptation and made a scientific enterprise, enlisting not only legislative aid, but also the resources of a learned Society and the pride of all good citizens. The enterprise is kept upon a State footing, honorable to Maryland, while entirely in the hands of a trustworthy record commission.

The Maryland Historical Society, when it shall have made the archives of the State generally accessible to students, will be in a position to encourage original research. It has a publication fund of $20,000, left by George Peabody for the printing of papers elucidating the history of Maryland or of the country at large. At a recent meeting, the Society voted a considerable appropriation from its treasury toward securing copies of certain Maryland documents, missing in the Annapolis collection, and yet preserved in England, for it was the custom of the proprietary Government to send duplicates of all important Acts of provincial legislation to the mother country. The "Stevens Index of Maryland documents in the State Paper Office, London," will doubtless be of great service to Maryland in recovering some of her long-lost records. This index, or calendar, contains descriptions and abstracts of 1,729 Maryland documents, covering the period from 1626 to 1780, and thus admirably supplementing the Annapolis collection. The index was prepared many years ago at the suggestion and expense of Henry Stevens, and was by him sold for £100 to George Peabody, who presented it to the Maryland Historical Society. This gift, of trifling cost when compared with other benefactions to Baltimore by the same hand, will yet, like the Peabody Institute, increase and multiply in power in proportion to the growing appreciation of its significance.

Catalogue of the Library of the Peabody Institute.

The Peabody Institute in Baltimore has now in type something over 150 royal octavo pages of its catalogue, upon the preparation of which, by means of an analytical card catalogue, the working force of the library has been employed for the past thirteen years. It will require four or five years longer to complete the arrangement and printing of the catalogue, and it will then probably embrace over 4,000 pages, published in four or five volumes. The proof-sheets, covering thus far about two-thirds of the subjects and authors to be catalogued under the letter A, promise certain valuable improvements in the art of cataloguing public libraries in this country. Under a given subject, or author, will be found not merely an alphabetical arrangement of the main authorities and titles, but also an alphabetical grouping of the chief collateral material, monographs, essays, magazine articles, and the like, that may be found in the Peabody Library touching the subject or author in hand. For example, under the head of "Æsthetics" we find, first, an alphabetical list of authors who have written more or less systematic works upon this subject; and, second, in finer type, an alphabetical list of minor authorities, dissertations, and miscellaneous articles. The name of the author, if known, is the guiding principle of this arrangement, otherwise the catchword of the essay or monograph is given, like the names of authors, in bold heavy type, so as to attract the eye at once upon the closely-printed page. Under the head of an author, for example, "Arago, Dominique François Jean, 1786–1853," we find an alphabetical analysis of his "Œuvres complètes," seventeen volumes. Instead of reprinting the table of contents for each volume, the contents of the whole series are arranged alphabetically, the *catchword* (not necessarily the initial word) of the titles serving as a guide in the classification; for instance, "Sur l'*action calorifique* et l'action chimique de la lumière, v. 7; Sur les *chronomètres* et les pendules, v. 12." This system of registering articles by alphabetical catchwords becomes of immense value when applied to the publications of learned societies, like the literary collections of the French Institute, Cambridge Philosophical Transactions, the publications of the Royal Irish Academy, and of the academies of St. Petersburg, Berlin, Vienna, Brussels, and the archives of Munich, and even to English and American reviews. Most catalogues, if they take any notice at all of the contents of a long series of volumes, simply give the contents of each volume by itself, the result being, in the case of a very long series, that a student is sometimes obliged to look through several pages of chaotic titles in order to ascertain whether there is any material relating to the subject he may have in hand. This annoyance and grievous waste of time will be entirely spared if the Peabody idea is systematically carried out and subject-titles are arranged alphabetically with appended references to volumes, but without regard to the succession of volumes. It should be as easy to find one's way through a vast collection of monographs and special treatises as through a complete dictionary of the English or French language. The body of existing science should be an encyclopædia of knowledge, properly indexed for the use of students, so that they may add to its volume without duplicating the work of predecessors.

The practical difficulties and labor involved in such a classification are beyond all estimate, for the present state of the world's scientific papers is but little removed from chaos. The Peabody idea has not yet been applied to the classification of the special articles on natural science to be found in the journals of European academies, but very much has been done in the fields of literature, art, and history. The idea is capable of indefinite expansion, and is only a suggestion of what the art of cataloguing a great public library of research may one day become. The responsibility of the Peabody undertaking falls upon the Provost of the Institute, Dr. N. H. Morison, who, in his personal direction of this great work, is ably seconded by Mr. Philip R. Uhler, the official librarian of the Peabody. The pains these gentlemen have taken in simply laying the foundations for this catalogue is not, and cannot yet be, appreciated by the general public. The special, analytical card catalogue, registering not merely all books entered upon the public card catalogue, but all magazine articles, analyses of journals and literary collections, was an indispensable preliminary to a published catalogue. This work, when finished, will be a vast collection of bibliographies—literally thousands of classified lists—which will prove of the greatest value to Baltimore specialists, in showing what resources are already available, and will also be of the greatest convenience to the public at large.

A NOTE ON TRIPLE OBJECTIVES.

The last number of the *Vierteljahrsschrift der Astronomischen Gesellschaft* contains a review of a paper On Triple Objectives, with Complete Color Correction, which was published in the *American Journal of Science*, (1879). The reviewer has apparently mistaken a table of differences, which are derived from calculations entirely independent of all theory, as an indication of the inexactness of the method there pursued; at least such must be the conclusion from his having followed the table for comparison with a wholly irrelevant quotation of the maximum residual found by Professor Schmidt in applying a formula for expressing indices of refraction as a function of wave length. These differences depend almost exclusively upon errors in the measures of indices, which enter here multiplied by large coefficients. Had he referred to the table of residuals he would have found that, in the group of refractive indices discussed in both papers, the simpler empirical formula chosen gives no residual as large as that quoted from Professor Schmidt's work, and in the group of more accurately determined indices from an earlier paper by the same writer, the formula is much more satisfactory.

Again, the reviewer objects to the suggestion of an error in n_E of Fraunhofer's Flint 13, because Professor Schmidt did not recognize it, not observing that this is a matter of course since he used the fictitious values of the indices derived from his empirical formula, whereas the author used the values as given directly by the observations. If a similar course had been followed in this paper all the differences would have been zero.

CHARLES S. HASTINGS.

Johns Hopkins University, May 13, 1882.

The lectures of Professor SIMON NEWCOMB on the Principles of Taxation, announced for the current academic year, were postponed by reason of sickness and other causes. It is expected that they will be delivered in November next.

The CHESAPEAKE ZOÖLOGICAL LABORATORY, for the study of forms of marine life, began its session for the season, under the direction of Dr. Brooks, at Beaufort, N. C., on May 1. The usual number of students have been enrolled.

The SEMI-ANNUAL EXAMINATIONS will begin on May 22 and continue daily till June 5. The entrance examinations will be in progress from June 5 to 8.

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No. 262 West Baltimore Street, Baltimore. Price 5 cents each.

[THIS NUMBER IS ESPECIALLY DEVOTED TO STATEMENTS OF THE WORK OF THE PAST YEAR AND TO THE PROGRAMMES FOR THE NEXT ACADEMIC YEAR.]

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CALENDAR FOR THE ACADEMIC YEAR, 1882–83.

September 19.	**Next Term Begins.**
September 20—23.	**Examinations for Matriculation.**
September 26.	**Instructions Resumed.**
June 9.	**Next Term Closes.**

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MEETINGS OF SOCIETIES.

Scientific. First Wednesday of each month, at 8 P. M.
S. H. Freeman, Secretary.

Philological. First Friday of each month, at 12 M.
M. Warren, Secretary.

Metaphysical. Second Tuesday of each month, at 8 P. M.
B. I. Gilman, Secretary.

Historical and Political Science. Third Friday of each month, at 8 P. M.
H. B. Adams, Secretary.

Mathematical. Third Wednesday of each month, at 8 P. M.
O. H. Mitchell, Secretary.

Naturalists' Field Club. Excursions each Saturday during the Spring and Autumn. Regular meetings for the reading and discussion of papers once a month.
H. F. Reid, Secretary.

For further information, during the summer vacation, letters should be addressed to the "JOHNS HOPKINS UNIVERSITY," Baltimore, Md., and not to the individual Professors, who are likely to be absent from the city.

MATHEMATICS.

WORK OF THE PAST YEAR.
1881-82.

The study of Mathematics has been pursued in the Johns Hopkins University, during the last academic year, by a company of thirty-two students, of whom twenty-one followed advanced or university courses and eleven pursued collegiate courses. The roll for the year includes the following names:—

J. J. Sylvester, D. C. L., F. R. S., *Professor.*
A. Cayley, D. C. L., F. R. S., *Lecturer.*
C. S. Peirce, (U. S. Coast Survey), *Lecturer.*
W. E. Story, Ph. D., *Associate.*
T. Craig, Ph. D., *Associate.*
F. Franklin, Ph. D., *Assistant.*

W. P. Durfee, A. B., *Fellow.*
G. S. Ely, A. B., *Fellow.*
S. H. Freeman, A. M., *Fellow.*
B. I. Gilman, A. M., *Fellow.*
C. H. Koyl, A. B., *Fellow.*
O. H. Mitchell, A. M., *Fellow.*
H. M. Perry, A. B., *Fellow.*
R. W. Prentiss, A. B., *late Fellow.*
E. D. Preston, C. E., *late Fellow.*
Christine Ladd, A. B.

E. Barnes, S. B.
J. C. Bland, C. E.
D. B. Brace, A. B.
E. W. Davis, S. B.
D. T. Day, A. B.
H. R. Goodnow, A. B.
A. S. Hathaway, S. B.
C. A. Perkins, A. B.
C. C. Norwood, A. B.
H. F. Reid, A. B.
A. A. Veblen, A. M.

A. C. Applegarth.
G. Bissing.
C. W. R. Crum.
L. M. Huggins.
G. A. Liebig.
J. Page.
N. M. Parrish.
W. H. Perkins.
H. H. Wiegand.
H. W. Williams.
W. J. Witzenbacher.

The head of the department is Professor Sylvester, who has delivered two courses of lectures—one, in the early part of the session, on the Theory of Numbers (and in especial on an extension of Tchebycheff's theory concerning prime numbers); the other, between January and June, on a New Theory of Universal Multiple Algebra.

Professor Cayley, Sadlerian Professor of Pure Mathematics in the University of Cambridge, came to this country, by invitation of the Trustees, at Professor Sylvester's suggestion, in December last, and since the commencement of the year, has delivered a systematic and highly original course of lectures upon Algebraical Geometry, in connection with the Abelian and Theta Functions.

These professors have lectured, alternately, to a class of fourteen students, on Monday, Tuesday, Thursday, and Friday.

Several shorter courses of mathematical lectures have been given, (like the former intended for hearers of superior attainments), on Wednesdays and other days, viz: by Mr. C. S. Peirce, (three lectures), on the Logic of Relatives; by Dr. Story, (six lectures), on the Clebsch-Gordan Invariantive Theory; and by Dr. Craig, (three lectures), on the Construction and Dissection of a Riemann's Surface.

Courses have also been conducted, in the regular classes, by

Dr. Story, in
- Quaternions, *three lectures weekly.*
- Higher Plane Curves, (Advanced Course) *three lectures weekly, first half-year.*
- Solid Analytic Geometry, *three lectures weekly, second half-year.*
- Conics, *three times weekly, first half-year.*
- Higher Plane Curves, (Elementary Course) *three times weekly, second half-year.*

Dr. Craig, in
- Calculus of Variations, *two lectures weekly, first half-year.*
- Spherical Harmonics, *two lectures weekly, first half-year.*
- Mechanics, *three lectures weekly, first half-year.*
- Elliptic Functions, *three lectures weekly.*
- Elasticity, *three lectures weekly, second half-year.*
- Partial Differential Equations, *three lectures weekly, second half-year.*

Dr. Franklin, in
- Modern Algebra, *two lectures weekly, second half-year.*
- Total Differential Equations, *three times weekly, first half-year.*
- Solid Analytic Geometry, (Elementary Course) *three times weekly, first half-year.*
- Differential and Integral Calculus, *three times weekly.*
- Theory of Equations, *three times weekly, second half-year.*

Lectures on Mathematical Physics have also been given by Professor Rowland and Dr. Hastings.

The Mathematical Seminary, which constitutes in fact the Mathematical Society of the University, has held eight meetings, at which papers have been presented and discussed. Other communications have been read before the Johns Hopkins Scientific Association, and at less formal meetings. The titles and subjects of these papers are specified below.

By Professor Sylvester, on a certain integrable class of differential and finite difference equations; on the completion of the author's method of obtaining the ground forms to any binary quantic or system of binary quantics; a question in partitions; a geometrical proof of a theorem in numbers; a geometrical treatment of a theorem in numbers; the properties of a split matrix; (with F. Franklin) a logical problem connected with assurances on joint-lines; on mechanical involution; and on nonions.

By Professor Cayley, on two cases of the quadric transformation between two planes; a problem of analytical geometry; the geometrical representation of an equation between two variables; on associative imaginaries; on the geometrical forms called trees; the geometrical interpretation of certain formulæ in elliptic functions; on eight-square imaginaries; and on the formulæ of trigonometry.

By Mr. Peirce, on the relative forms of quaternions.

By Dr. Story, on a system of conchordal conics; analytical proof of some properties of binodal quartics; and on the non-euclidean trigonometry.

By Dr. Craig, on an n-fold potential; a geometrical theorem; on areas of corresponding surfaces.

By Dr. Franklin, on a class of ordinary differential equations of the first order and degree; on the probability of the existence of an error in the result of a certain computation; on cubic curves; and on cubics and systems of conics.

By Mr. Mitchell, on the residues of symmetric functions; on partitions; on the algebra of logic; and on the determinant of powers.

By Mr. Durfee, on some properties of the numerical solutions of $ax^2 - y^2 = -1$.

By Mr. G. S. Ely, on the determination of the number of the even and of the odd integer roots of an equation; and on partitions.

By Mr. Perry, on singular solutions of differential equations.

By Mr. Davis, on binodal quartics.

PHYSICS.

WORK OF THE PAST YEAR.
1881-82.

The study of Physics has been pursued by forty-two students, of whom twenty were advanced or graduate, and twenty-two undergraduate students.

The roll for the year includes:

H. A. Rowland, Ph. D., *Professor.*
C. S. Hastings, Ph. D., *Associate.*

W. C. Day, A. B., *Fellow.*
G. S. Ely, A. B., *Fellow.*
S. H. Freeman, A. M., *Fellow.*
C. H. Koyl, A. B., *Fellow.*
H. M. Perry, A. B., *Fellow.*

E. Barnes, S. B.
D. B. Brace, A. B.
P. H. Broun.
J. R. Duggan, A. M., M. D.
H. R. Goodnow, A. B.
C. C. Hall.
E. Haworth, S. B.
O. A. Johnson, S. B.
E. H. Keiser, S. M.
W. J. Loudon, A. B.
W. N. Mumper, A. B.
W. A. Noyes, A. B.
C. A. Perkins, A. B.
H. F. Reid, A. B.
A. A. Veblen, A. M.

T. L. Cole.
D. B. Dorsey.
C. Frick.
H. Friedenwald.
W. L. Glenn.
W. J. Guard.
L. M. Huggins.
J. T. Hyslop.
G. T. Kemp.
J. D. Lord.
J. W. Lord.
C. W. E. Miller.
E. G. Miller.
J. Page.
A. G. Palmer.
N. M. Parrish.
G. D. Penniman.
T. H. Randall.
R. M. Reese.
G. C. Stokes.
I. R. Trimble.
H. V. Wilson.

The Physical Laboratory has been open daily for the prosecution of advanced study and research, under the direction of Professor Rowland.

During the year original investigations in the following subjects, among others, have been carried on:

On the problem of electrification by evaporation.
On the determination of the diamagnetic constants of bismuth in absolute measure.
On the effect of electrostatic attraction on electrical resistance.
On the action of electrical displacement and conduction currents on the propagation of light.
On certain problems connected with the phenomena of vision.
On secondary batteries.

A dividing engine for ruling gratings has been completed, and one of the gratings ruled by it is being used for experiments on the ultra-red rays of the spectrum.

A concave grating, having very important and useful properties, has been invented, and preliminary experiments have been made with it for the determination of relative wave lengths and the photographing of the normal spectrum, as well as the preliminary mapping of portions of the spectrum. Apparatus has been partly constructed for mapping and photographing the spectrum in an elaborate manner.

Preparations have also been made to attempt the detection of electrical displacement currents in dielectrics by magnetic means.

Advanced students have also taken part in meetings weekly, for the reading and discussion of the current physical journals.

Lectures have also been given by Professor Rowland on Hydrodynamics, four times weekly, during the first half-year; on the Theory of Heat Conduction and the Theory of Sound, four times weekly, during the second half-year.

The work of a part of the students has been guided by Dr. Hastings. The major course has included lectures, weekly, through the year, and daily work in the laboratory, especially on Wednesdays. The minor course in General Physics has included instruction daily through the year in Elementary Mechanics, Acoustics, Heat, Magnetism, Electricity, and Light, and a weekly exercise in the laboratory under Dr. Hastings and Mr. Freeman.

PROGRAMME FOR THE YEAR BEGINNING SEPTEMBER 19, 1882.

I. Minor Course.

This course, which will be conducted by Dr. Hastings, embraces experimental lectures, recitations, and examinations, five times a week throughout the year, with one half-day each week given to laboratory work. The subjects taken up will include Mechanics, Acoustics, Optics, Light, Heat, Electricity, and Magnetism.

This course precedes the study of Chemistry and Biology as taken by the students in the Course Preliminary to Medicine. A knowledge of Plane Trigonometry is essential for admission to the course.

II. Advanced Courses.

Professor Rowland:

1. Electricity and Magnetism.
   Four lectures weekly.
2. Meetings for the Discussion of Current Literature.
   Weekly.

Dr. Hastings:

3. Theory of Errors.
   Six lectures.
4. Application of Mathematics to Selected Problems in Physics.
   Lectures weekly.
5. Theory of Optical Instruments.
   Six or eight lectures.
6. Courses of Selected Readings in Physics by the students, with examinations.
   Heretofore these have embraced selections from the following works, one from each group being requisite:
   Sound: Helmholtz.
   Heat: Maxwell, Wüllner, Verdet, Tyndall.
   Electricity and Magnetism: Jenkin, Wüllner, Verdet.
   Light: Wüllner, Lloyd, Daguin, Jamin, Verdet.
   Conservation of Energy: Youmans, and others.

Dr. Craig:

7. Mechanics.
   Three times weekly, first half-year.
8. Hydrodynamics.
   Three times weekly, second half-year.
9. Partial Differential Equations.
   Twice weekly, second half-year.

III. Laboratory Work.

Professor Rowland:

10. Will have the general guidance of those engaged in research.
11. Will direct a course of work daily through the year.

Dr. Hastings:

12. Will assign special problems and review written reports on them.
    Daily, especially Wednesdays.

Note.—No one will be admitted to the advanced courses who has not attainments equivalent to those required for the completion of the Minor Course.

Courses by Dr. Morse:

Analytical Chemistry, *three times weekly, first half-year.*
General Chemistry (Non-Metals), *five times weekly, second half-year.*
Mineralogy, lectures and laboratory work, *three times weekly, through the year.*

by Dr. Coale:

Examinations on the Non-Metals, and Recitations on Remsen's "Theoretical Chemistry."

Five numbers of the **American Chemical Journal** have appeared within the year. These are Nos. 4, 5, and 6 of Volume III, and Nos. 1 and 2 of Volume IV. The third volume is thus completed. This journal was begun in 1879, and since then there have appeared in it, besides papers by the editor, Professor Remsen, others by

E. Ador,
H. P. Armsby,
M. Beamer,
A. A. Blair,
P. H. Broun,
B. S. Burton,
R. H. Chittenden,
F. W. Clarke,
R. D. Coale,
H. B. Cornwall,
J. M. Crafts,
W. C. Day,
F. W. Dewey,
H. H. Donaldson,
T. M. Drown,
W. L Dudley,
J. R. Duggan,
F. P. Dunnington,
C. Fahlberg,
F. A. Genth,
F. A. Genth, Jr.
Wolcott Gibbs,
T. S. Gladding,
F. A. Gooch,
W. H. Greene,
W. L. Griswold,
L. B. Hall,
E. J. Hallock,
E. Hart,
C S. Hastings,
H. B. Hill,
M. W. Iles,
C. L. Jackson,
E. H. Jenkins,
John Jewett,
S. W. Johnson,
L. P. Kinnicutt,
G. A. König,
M. Kuhara,
S. W. Lambert,
R. Lloyd,
W. Lowery,
C. F. Mabery,
J. B. Mackintosh,
R. W. Mahon,
J. W. Mallet,
H. G. McCarter,
Fr. Meier,
Victor Meyer,
A. Michael,
W. G. Mixter,
E. W. Morley,
H. N. Morse,
L. M. Norton,
M. E. Owens,
C. Palmer,
H. B. Parsons,
S. L. Penfield,
G. K. Peirce,
A. B. Prescott,
C. Richardson,
S. P. Sadtler,
W. D. Schoonmaker,
W. T. Sedgwick,
E. F. Smith,
A. Springer,
H. Stallo,
D. Stern,
J. M. Stillman,
T. E. Thorpe,
J. A. Van Mater,
R. B. Warder,
J. F. White,
H. W. Wiley,
A. V. E. Young.

PROGRAMME FOR THE YEAR BEGINNING SEPTEMBER 19, 1882.

Chemical Laboratory.

The necessity for a larger laboratory has been recognized by the Trustees, and during the summer extensive additions are to be made to the present building. When completed the laboratory will cover an area of about 50 by 100 feet, and will have three stories and a basement. In the basement there will be the necessary conveniences for assaying and other furnace operations. On the next floor there will be large rooms devoted mainly to qualitative and quantitative analysis. On the second floor will be the working room for advanced students, the rooms of the professor, the library, lecture room for General Chemistry, etc. On the third floor will be a large room for the chemical and mineralogical collections, a working and lecture room for mineralogy, and a second lecture room for chemistry. There will be room for nearly 100 workers in the building.

The courses in Chemistry are intended to meet the wants: 1st. of graduates who make Chemistry their specialty, or who select it as their subordinate subject for the degree of Doctor of Philosophy; 2d. of undergraduate students who study Chemistry for general training; 3d. of special students who for good reasons have neither received a bachelor's degree nor matriculated at this university. The minor and major courses are designed mainly for undergraduates, though graduates and special students who have not done an equivalent amount of work will be required to follow such portions of these courses as may seem desirable.

I. Advanced Work.

1. Laboratory Work.

Most of the work of advanced students is carried on in the laboratory, which will be open to them daily, except Saturday, from 9 a. m. until 5 p. m. The work will be wholly under the direction of Professor Remsen.

A detailed account of this part of the work cannot well be given. The object in view is to make thorough chemists who shall be not only skillful workers, but, as far as circumstances will permit, clear thinkers. The reading of the journals of chemistry is encouraged, and to some extent made obligatory, and oral reports on the articles read are required. The attempt is made to familiarize the students, as far as possible, with the whole range of chemical literature.

2. Lectures.

Advanced topics will be treated in lectures which will be given two or three times weekly. Professor Remsen will direct these lectures and will give most of them, but some will be given by the Fellows and other advanced students. They will be mainly historical in character, with the main object of showing upon exactly what foundation many of the most important conceptions of chemistry rest. This work, while serving to familiarize students with chemical literature, is intended also to aid them in acquiring the art of presenting subjects in the form of lectures before audiences. All those who look forward to the careers of teachers of chemistry will be required to take active part in the exercises.

II. Minor Course.

This course occupies a year, and consists of laboratory work and lectures or recitations.

1st Half-Year: General Chemistry; Non-Metals.
Lectures and recitations daily except Saturday.
Laboratory Work.
Daily except Saturday, 2–4 p. m.
2d Half-Year: General Chemistry; Metals.
Lectures and recitations daily except Saturday.
Laboratory Work.
As above, continued.

III. Major Course.

This course requires two years' work. The first is the minor course just described. The second is as follows:

1st Half-Year: Analytical Chemistry.
Lectures and examinations three times weekly.
Laboratory Work.
Daily except Saturday, 2–5 p. m.
2d Half-Year: Chemistry of the Compounds of Carbon.
Lectures and examinations daily except Saturday.
Laboratory Work.
As above, continued.

IV. Mineralogy.

The work in Mineralogy will be under the direction of Dr. Morse.

The minor course will consist of lectures and laboratory work three times weekly, each session continuing for three hours. This course is open only to those who have taken at least a minor course in Chemistry.

V. Applied Chemistry.

In the new chemical laboratory arrangements will be made for work in Applied Chemistry, as for example, metallurgy, the chemistry of iron and steel, of dye-stuffs, of soils and fertilizers, etc.

More detailed statements regarding this work will be made later, though it should be said here that the instruction will be intended for those who already have a good knowledge of General Chemistry, and have done an amount of laboratory work at least equivalent to that of the major course above described.

III. Class Instruction.

Courses of lectures have been given during the year as follows:

Osteology, *four times weekly, until Christmas; then twice weekly, until April.*
Mammalian Anatomy, *twice weekly, until April.*
Animal Physiology, *four times weekly.*
General Biology, *three times weekly, until May.*
Embryology of the Chick, *three times weekly, during May.*
Plant Analysis, *twice weekly, during May.*

IV. Marine Laboratory.

Marine Laboratory. During the summer of 1881, the seaside Zoölogical Laboratory for the study of forms of marine life, was open at Beaufort, N. C., from May 1 until September 1. The following were present during part or the whole of that period:

W. K. Brooks, Ph. D., *Director.*
E. B. Wilson, Ph. D., *Assistant.*
S. F. Clarke, Ph. D., *Assistant.*
H. Sewall, Ph. D., *Associate in Biology, J. H. U.*
P. R. Uhler, *Associate in Biology, J. H. U.*
H. J. Rice, M. S., *Prof., Natural Science, Mich. Military Academy.*
J. Playfair McMurrich, *Assistant in Biology, University of Toronto.*
Buel P. Colton, A. B , *Teacher of Nat. Science, Princeton (Ill.) High School.*
H. Garman, *Assistant, State Lab. Nat. History, Normal, Ill.*
Jas. E. Armstrong, S. B., *Assistant, Nat. Hist., Ill. Indust. University.*
W. L. Norris, *Arlington, Ill.*
Fernando Sanford, *Professor, Natural Science, Mount Morris College, Ill.*

The five last named came to Beaufort to attend the elementary class which was conducted by Dr. Clarke during six weeks, but all, except the two last, remained at the laboratory and engaged in research after the elementary course was finished.

The advanced work at the Marine Laboratory included the following original investigations:

On the development of marine Annelides; on the development of Renilla; the equilibrium functions of the semicircular canals of the ear; on the origin of the "test-cells" of the eggs of Ascidia; on the development of Arbacia; on the Medusæ of Beaufort, with a description of several new species; on the development of Macroura.

In connection with the elementary class, Dr. Clarke lectured daily on Zoölogy, and guided the students in the dissection and study of typical marine animals, and in the methods of collecting and preserving them.

V. Publications.

Two parts (2 and 3), of the second volume of the "*Studies from the Biological Laboratory,*" have appeared during the year. These contained the results of several of the researches already named, and in addition the following papers:—

W. H. Howell and F. Donaldson, observations on blood pressure and pulse in a case of open *ductus arteriosus* in a dog.

H. N. Martin and W. T. Sedgwick, observations on the blood-flow in the coronary arteries of the heart.

K. Mitsukuri, on the structure and significance of some aberrant forms of lamellibranchiate gills.

H. Sewall, on the polar effects upon nerves of weak induction currents.

A. F. W. Schimper, on the development of starch granules.

G. M. Sternberg, a contribution to the study of the bacterial organisms commonly found upon exposed mucous surfaces and in the alimentary canal of healthy persons; a fatal form of septicæmia in the rabbit, produced by the subcutaneous injection of human saliva; experiments with disinfectants.

These additional papers are the results of work carried on in the Laboratory during the preceding session, 1880–81.

[illegible] numbers and supplement of the Journal of Physiology, published in America under the auspices of the Johns *University,* have also been issued.

PROGRAMME FOR THE YEAR BEGINNING SEPTEMBER 19, 1882.

I. Minor Course.

This minor course has been planned to meet the needs (1): of those who desire ultimately to take up some one branch of Biology (Zoölogy, Physiology, or Botany) for special study; (2) of students, graduate or undergraduate, who intend ultimately to study medicine, but meanwhile, as a valuable preparation, desire to obtain some general knowledge of the phenomena, laws, and conditions of life; and (3) of those who, desiring as part of a general education some acquaintance with the methods and modes of thought of modern experimental and observational science, select Biology as a subject of study, with that end in view.

The course consists of five lectures or recitations weekly throughout the year, with work in the laboratory. The following subjects form the topics of the year's work.

1. General Biology.

Three lectures or recitations weekly from the commencement of the session until the middle of April.

At the outset attention is mainly directed to the broad characteristic phenomena of life and living things; the student in the laboratory examines selected vegetable and animal types, from the yeast-plant to a fern and a flowering-plant, and from Amœba to a Crayfish and a Mammal. In the lecture room attention is chiefly given to the fundamental biological facts which the animal or plant under consideration is fitted to illustrate, rather than to the minutiæ of Systematic Botany and Zoölogy or the characters of particular orders, genera, and species. In the laboratory the student learns how to observe for himself, how to verify and describe what he observes, how to dissect, and how to use a microscope.

2. The Embryology of the Chick.

Three lectures or recitations weekly from the middle of April until the close of the session.

In this course the student, who has already in his course in General Biology noted the natural arrangement of animals and plants in diverging series ranging from a simple bit of living matter to highly complicated organisms, studies the individual development of one of the higher animals, from its start as an almost formless bit of living matter to its final highly complicated condition. The increasing differentiation of tissues and organs which he has already observed as higher and higher plants and animals were dissected, he now sees actually exemplified by the study of his sections of the embryo bird in different stages of its development. At the same time a firm basis is laid for subsequent advanced study of Vertebrate Morphology.

3. Human and Comparative Osteology.

Two lectures or recitations weekly from the beginning of the session until April.

4. Plant Analysis.

Twelve practical lessons in April and May.

The courses on Osteology and Plant Analysis are designed to supplement the other courses above named, by teaching the student to observe details accurately and closely. The human skeleton, being the most minutely and accurately described of all conveniently accessible animal structures, and, moreover, nearly all the terminology of Comparative Osteology being derived from it, is selected as the starting point. The acquaintance with it thus obtained, as a part of his preliminary training, is also a special help to a student who subsequently enters a medical school.

5. Laboratory Work.

Requires about twelve hours weekly.

This to a great extent takes the place of the outside reading required in connection with most subjects; consequently, in spite of the hours given to laboratory work, the time required for the minor course in Biology is really not greater than that called for by the other minor courses offered in the University.

ANCIENT AND MODERN LANGUAGES.

WORK OF THE PAST YEAR.
1881-82.

ANCIENT LANGUAGES.

Courses in the Ancient Languages have been taken during the year by forty-nine students, of whom eighteen followed advanced or university courses and thirty-one pursued collegiate courses.

The roll for the year includes:

B. L. Gildersleeve, Ph. D., LL D., *Professor of Greek.*
C. D. Morris, A. M., *Collegiate Professor of Greek and Latin.*
W. W. Goodwin, Ph. D., LL. D., *Lecturer.*
M. Warren, Ph. D., *Associate in Latin.*
M. Bloomfield, Ph. D., *Associate in Sanskrit.*
G. F. Nicolassen, A. M., *Assistant in Greek and Latin.*

W. J. Alexander, A. B., *Fellow.*
J. W. Bright, A. M., *Fellow.*
E. S. Burgess, A. B , *Fellow.*
E. H. Spieker, A. B., *Fellow.*
H. A. Short, A. B., *Fellow of Columbia College.*

T. Atkinson, A. M.
T. M. Beadenkopf, A. B.
W. S. Fleming, A B.
A. H. Giles, A. M.
J. G. Hamner, A. B.
O. F. T. Hanser.
B. L. Hobson, A. M.
A. Holstad, A. B.
K. S. Nelson, A. M.
S. Sale, Ph. D.
J. Sieber, A. B.
W. C. Thayer, A. B.
H. C. Warren, A. B.

A. C. Applegarth.
J. P. Campbell.
W. B Canfield.
G. G. Carey.
T. L. Cole.
W. K. Cromwell.
H. Duffy.
H. L. Ebeling.
L. Garthe.
J. Glenn.
W. L. Glenn.
M. Gregg.
W. J. Guard.
J. Hinkley.
E Ingle.
E. F. Keerl.
R. F. Kimball.
G. Lodge.
J. D Lord.
C. T. McDaniel.
C. W. E. Miller.
E G. Miller.
G. D. Penniman.
W. H. Perkins.
P. M. Prescott.
L. B. Robinson.
G C. Stokes.
H. T. Tiffany.
W. Walz.
H. W. Williams.
W. J. Witzenbacher.

Under the direction of Professor Gildersleeve the advanced students have been organized into a Greek Seminary. According to the plan of this seminary the work of each year is concentrated on some leading author or some special department of literature. During the past year the centre of work has been Plato, chiefly with reference to the literary form.

In the seminary proper, which met once a week during the academic year, the *Euthydemos* and the *Theaitetos* were interpreted by the members in turn, with analyses and introductions and the *Symposion*, *Republic*, and *Protagoras* were analyzed. Papers were presented, read, and discussed on the *Euthyphron*, on the aim and result of the *Theaitetos*, on Dionysios' criticism of the style of Plato. Studies were made in Platonic Syntax and on the relation between the discourses of Sokrates in the *Symposion* and in the *Phaidros*. Some work growing out of the studies of the preceding seminary year was completed, such as an exhibit of the use of the so-called genitive absolute in the orators. A study on ἐπί in the orators begun the preceding year was extended to Homer and Plato, and in continuation of a line of syntactical investigations opened several years since by the director, statistics of the articular infinitive in Xenophon and Plato were prepared by members of the seminary. The results of some of these investigations will be prepared for publication before long. A survey of Homeric comparisons grew out of the consideration of the comparison in Plato, which was the theme of an earlier seminary essay. Professor Goodwin, of Harvard University, conducted the seminary for one meeting, in order to prepare the members for his presentation of the *Line* and the *Cave* in the *Republic.*

With special reference to the work of the seminary, the Director lectured once a week during the term on the *Symposion* of Plato, and weekly readings were conducted by him in the *Phaidros* from February 7 to May 16. A course of eighteen readings in the Fragments of the pre-Socratic Philosophers and a short series of lectures on the Platonic Canon were intended to supplement a course of lectures on Greek Philosophy, which were given three times weekly during the first half-year by Professor G. S. Morris. Professor Gildersleeve also delivered some thirty lectures on Greek poetical literature, and conducted twenty-two exercises in translating Greek into English and English into Greek at dictation.

Two courses, including about forty lectures in all, were given by Dr. M. Bloomfield on the Comparative Study of Indo-European Vocalism, with especial reference to Greek, and on Greek Accent in the light of the latest investigations on that subject.

A course of three public lectures on the *Republic* of Plato was also given by Professor W. W. Goodwin, with an average attendance of one hundred and fifty-two.

The Latin Seminary under the direction of Dr. Warren held two sessions a week throughout the year, the author selected for special treatment being Vergil.

A preliminary course of ten lectures was given on the Ancient Lives of Vergil, on the MSS., Commentators, and Scholia, and on Vergil's place in Roman Literature. Occasional lectures were given during the year on various topics connected with Vergilian criticism. Special attention was paid to the Syntax of Vergil and his influence upon subsequent writers, and to the development of the Hexameter from Ennius down to Ovid. Some metrical statistics were collected by members of the seminary, and papers were read summing up recent views of Vergil's imitation of Greek Poets, on his archaisms, and his value for the illustration of Roman antiquities. All of the Eclogues and Georgics were analysed by the members in turn, and four of the Eclogues, the Episode of Aristaeus in Book IV of the Georgics, and portions of Books I, VI, and VIII, of the Aeneid were made the subject of critical interpretation.

During the latter half of the year Dr. Warren conducted a course of weekly exercises in the Interpretation of Early Latin Inscriptions.

The course was given in one of the rooms of the Peabody Institute, and wherever possible fac-similes of the inscriptions were used. This course included two lectures on Latin Epigraphy in general, and one on the Saturnian verse.

Dr. Warren also lectured weekly in the latter half of the year to advanced and graduate students on the Syntax of Early Latin.

In Sanskrit, one elementary and two advanced courses were conducted through the year by Dr. Bloomfield, who also instructed a class in Hebrew during the second half-year.

After a course of instruction in grammar, seven books of the *Nala* and an episode of the *Mahābhārata* were read by the elementary class, which met three times weekly. One of the advanced classes, meeting twice weekly, read five tarangas of the *Kāthasaritsāgara* and a part of the first book of the law treatise of the *Yājñavalkya*, and the other was guided in a course of comparative reading in the *Gṛhyasutras* and their commentaries.

I. Germanic Languages.

A. German, Gothic, &c.

Advanced Courses were conducted by Mr. Brandt as follows:

Gothic, *once weekly.*

Middle High German, *once weekly through the year, and twice weekly second half-year.*

German Literature, consisting of lectures in German and essays by the student, requiring private reading, *on alternate Saturdays.*

Deutsche Stilübungen, *once monthly.*

Reading of the classical authors, *four times weekly.*

Prose Composition, *once weekly.*

The minor course classes were instructed by Mr. Brandt four times weekly.

Selections were read from Goethe's, Schiller's, and Humboldt's Prose; Goethe's *Götz von Berlichingen*,. and one exercise was given weekly in grammar and prose composition.

Students have read privately for examination:

Selections from Humboldt's, Schiller's, and Goethe's Prose, (3).

The "*Sturm und Drang*" works of Schiller and Goethe, (1).

Lessing's *Minna v. Barnhelm*, (1); *Emilia Galotti*, (2); *Nathan*, (2); *Laocoön*, (1).

Schiller's *Wallenstein*, (2); *Jungfrau von Orleans*, (1); *Tell*, (1).

Goethe's *Faust*, I. and II. (2).

Wieland's *Oberon*, (1).

[The classes in German were attended by forty-seven students.]

B. Anglo-Saxon and English.

Two advanced classes in Anglo-Saxon and Early English, each meeting twice weekly, have been conducted by Dr. Wood.

The first has read the greater part of Grein's *Bibliothek der Angelsächsischen Poesie*, and Wülcker's *Altenglischen Lesebuch*, Pts. I. and II.; and has worked upon Comparative Anglo-Saxon Grammar. The same class has also done some work in Old Saxon and Icelandic. The second advanced class has read Beówulf.

Besides these the following less advanced classes, including the minor course classes, were conducted by Dr. Wood.

Introduction to Anglo-Saxon, *twice weekly, first half-year.*

Chaucer, The Prioresses Tale, etc., *twice weekly, first half-year.*

Chaucer, The Prologue, etc., *four times weekly, second half-year.*

Shakspeare, Macbeth, *five times weekly, first half year.*

Early English, Selections, etc., *twice weekly, second half-year.*

English Style, Milton's *Areopagitica*, etc., *once weekly, second half-year.*

[The classes in English were attended by twenty-two students.]

II. Romance Languages.

Advanced courses were conducted by Mr. Elliott, as follows:

Old French, including the critical examination of the three oldest literary monuments of the French language, (Oaths of Strasbourg, Cantilène de Ste Eulalie, and Fragment de Valenciennes), *twice weekly;* lectures on Old French Syntax in its relation to the Latin and Modern French Syntax, *twice weekly, second half-year;* Aucassin and Nicolète, *twice weekly.*

Provençal, investigation of the sources of the earliest stages of the language, as represented in the *Poème sur Boëce*; Reading of extracts from *Girart de Rossilho, twice weekly.*

Romance Dialects, *weekly.*

Italian, *Dante, twice weekly, first half-year.*

Spanish, *Don Quijote, twice weekly, second half-year.*

French Phonetics, *weekly.*

Lectures were also given on the principles of Gunation in the Romance strong verb system; on the historic development of the past participle in Old, Middle, and Modern French; and on Dante's *Inferno.*

In French the minor course classes were instructed by Mr. Marcou five times weekly.

The reading embraced Töpfer, *Nouvelles Genevoises;* Michelet, *Jeanne D'Arc;* Laboulaye, *Paris en Amérique;* Taine, *Histoire de la littérature laise, Vol.* IV.; Sandeau, *Mdlle de la Seglière.*

Two public courses on French Literature, including twenty-four lectures and readings, were given (in French) by M. Rabillon, with an average attendance of forty-eight. He also conducted a class in French conversation.

[The attendance upon the classes in Romance Languages, including the French minor course, was twenty-six.]

A list of the papers read before the Philological Association is given above.

PROGRAMME FOR THE YEAR BEGINNING SEPTEMBER 19, 1882.

GREEK AND LATIN; SANSKRIT AND COMPARATIVE PHILOLOGY.

I. Greek Seminary.

Professor Gildersleeve will conduct the Greek Seminary, the plan of which is based on the continuous study of some leading author or some special department of literature.

The Seminary consists of the Director, Fellows, and Scholars, and such advanced students, to the number of six, as shall satisfy the Director of their fitness for an active participation in the work, by an essay, a critical exercise, or some similar test of attainments or capacity. All graduate students, however, have the privilege of attending the course.

During the next academic year the study of Aristophanes and the old Attic comedy will constitute the chief occupation of the members. There will be two meetings a week during the entire session, one for the criticism and interpretation of the author, one for auxiliary studies in the literary and political history of the period.

The students should be provided with Bergk's or Meineke's text, and at least Kock's editions of the Knights, Clouds, Birds, and Frogs. Green's editions will also be found useful for beginners in Aristophanes.

The student should also possess Kock's Fragmenta Comicorum Græcorum so far as published, or Meineke's smaller edition of the same, and for the prosecution of the auxiliary course Aischylos, Sophokles, and Euripides, Thukydides, Xenophon's Memorabilia, Hellenika and minor writings, Plato's Symposion, Phaidros, Plutarch's Lives, and Aristotle's Poetic.*

The Seminary library contains an Aristophanic literature, sufficient for philological purposes, and to this collection important new works are added, as they appear.

II. Greek (*for advanced and graduate students.*)

1. **Professor Gildersleeve** will also conduct a course of practical exercises in Greek, consisting chiefly in translation at dictation from Greek into English and English into Greek, two meetings a week, from the beginning of the session to the first of January. Advanced undergraduates will be admitted to this course, when recommended by Professor Morris.

2. **Professor Gildersleeve** will interpret select odes of *Pindar*, thirty meetings, beginning after January 1.

3. He will also give a course of some twenty lectures on *Historical Syntax*, with special reference to the growth of the hypotactic sentence. Time to be announced hereafter.

Notices as to other courses are reserved.

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*It is important that students should provide themselves early with the necessary books, as much valuable time is lost by writing for importations.

3. **Middle High German.**
Paul's and Weinhold's Grammars. Reading of Epic Poetry. *Twice weekly.*

4. **German of the XVI. and XVII. centuries.**
Brant's *Narrenschiff*, Luther's "*An den Adel*," Gryphius' *Peter Squenz*. *Twice weekly* (*one half-year.*)

5. *a*. **Deutsche Stilübungen.**
Monthly.

b. **Prose Composition.**
Whitney's and Paul's Grammars. *Weekly.*

6. **History of German Literature.**
Lectures in German, with Kluge's *Deutsche Nationalliteratur*. *Once in two weeks.*

7. **Reading of German Classics (1765–1832).**
Four times weekly.

II. Minor Courses.

8. **Historical Prose.**
Dahn's *Urgeschichte der germanischen und romanischen Völker*. *Twice weekly.*

9. **Scientific Prose.**
Hodges' *Scientific German* and Humboldt *in Auswahl*. *Twice weekly.*

10. **Classics.**
Prose, one play, Minor Poetry. *Twice weekly.*

11. **Exercises, with Whitney's Grammar.**
Weekly.

NOTE.—Advanced and special students may choose any one or more of these courses. Collegiate students have some choice, under the direction of the instructor, in making out major and minor courses. Thus a major course might consist of courses 4, 5*b*, 6 and 7 (minus the two hours of 4); of 3, 4, 5*a*, 6 and two hours of 7; of 4, 5*b*, 6, 9 and three hours of 7; of 4, 5*b*, 6, 8 and three hours of 7. A minor course may be made up of 8, 10, 11; of 8, 9, 11; of 9, 10, 11; if the student is sufficiently far advanced, of 11 and two hours of 7.

As a rule, the minor course requires one year with at least five hours and one exercise weekly; the major course an additional year with at least five hours and an exercise weekly and course 6.

An elementary knowledge is required for admission to the minor course readings.

ENGLISH.

DR. H. WOOD will conduct the following courses:

I. Advanced Course:

1. **Anglo-Saxon.**
Sweet's Reader, Sievers' Grammar. *Twice weekly.*
Connected with this course there will be lectures on Anglo-Saxon Grammar once weekly during the first half-year. These are also designed to furnish an introduction to the Comparative Grammar of Anglo-Saxon to students of Gothic and Old High German.

2. **Early English, (1200–1400 A. D.)**
Mätzner's Reader, Koch's and Mätzner's Grammars, Literary History of the Period. *Twice weekly.*
It is desired that the members of this class should be able to read German.

3. **Old Saxon.**
Hêliand. *Weekly, second half-year.*

II. Minor Course:

4. **Anglo-Saxon.**
This course is intended for beginners. Together with instruction in the language, and the reading of selected works, particular attention will be given to Anglo-Saxon law, religion, and household customs. *Weekly.*

5. **Chaucer.**
The Prologue, etc.; Morris' Outlines of English Accidence. *Twice weekly, second half-year.*

6. **Shakspeare.**
Macbeth. Weekly, first half-year.

7. **Elements of English Phonetics.**
Weekly, first half-year.

8. **English Prose.**
Twice weekly.
A chief object of this study will be the attainment of correct and forcible expression in English, in connection with the reading of longer extracts from prose writers of the modern period. Particular attention will be paid to word-building, laws of derivation and definition, errors of expression, etc. The development of English literature will be shown by contrasting modes of thought and expression in different periods, with the aid of history and manners. Essays will be written every month; and at the end of the year each student will be expected to have read certain works, to be indicated to him by the instructor.

9. **Outside of the regular courses it is proposed to further the study of English in the two following ways:**

a. The instructor will receive and comment upon the language and literary form of essays written in any department of study, as an aid to the formation of a good style.

b. At intervals during the year there will be a series of conferences (sixteen to twenty in number), open only to members of the University, on the great English writers. The manner of treatment will be bibliographical, biographical, critical, and illustrative, as circumstances may indicate. No. 8 above will be in connection with these exercises.

NOTE.—The minor course marked out above is believed to meet a need of most if not all undergraduates, and they will generally be expected to take all the subjects offered. In particular instances, where satisfactory reason is given, students may omit all except No. 8. In connection with the whole course there will be regular exercises in Elocution for each student.

ROMANCE LANGUAGES.

I. Advanced Course.

The advanced work will be guided by **MR. A. M. ELLIOTT**, and will be concentrated upon the Norman Dialect in its relation to English. A part of the *os Lusiadas* of Camoens will be critically examined, and extracts from XII. century Provençal studied in their special relation to allied languages. There will also be two courses of lectures by Mr. Elliott, running through the year, on the Comparative Grammar of the Romance Languages, and on the Romance Dialects.

A course, including lectures and recitations twice a week, in the History of French Literature during the last three centuries, will also be given by **MR. MARCOU.**

Notice as to other courses is reserved.

II. Minor Course in French.

MR. P. B. MARCOU.

1. **Historical Course.**
Fustel de Coulanges, *La Cité Antique, etc. Twice weekly.*

2. **Scientific Course.**
Elisée Reclus, *La Terre, etc. Twice weekly.*

3. **Literary Course.**
Molière, *Le Bourgeois Gentilhomme, Les Femmes Savantes, etc. Twice weekly.*

4. **Exercises and Grammar.**
Weekly.

NOTE.—Students following the minor course in French must take the course marked 4, and two other of the above courses, so as to make five hours a week in all.

III. M. RABILLON will give courses of public lectures (*in French*) through the year, and will also give instruction to students who wish to perfect themselves in the use of oral and written French.

IV. Undergraduate Courses.

The less advanced course was also conducted by Dr. H. B. Adams, and consisted of class exercises, (lectures, examinations, oral reports, essays, etc.,) five hours weekly through the year.

The first half-year was devoted to Mediæval History, and the second half-year to Diplomatic History, with the principles of International Law, as embodied in Bluntschli's *Voelkerrecht*, of which the German text was expounded by teacher and class. Oral reports were made by students upon topics of contemporary international politics and the status of leading countries; exercises which accustomed the class to the use of maps, consular reports, government documents, texts of treaties, diplomatic correspondence, etc.

The Historical and Political Science Association has met monthly, as heretofore, for the presentation and discussion of papers, the titles of most of which have been given above.

PROGRAMME FOR THE YEAR BEGINNING SEPTEMBER 19, 1882.

I. Graduate and Advanced Courses:

Dr. H. B. Adams.

1. Sources of English Constitutional History.

This class will meet in the small lecture-room at the Peabody Institute, by permission of the Provost, for facility of reference to the library collections. A knowledge of Latin and German is requisite for admission to this course.—*Once weekly, first half-year.*

2. American Institutional History.

This will be an advanced course for the report and discussion of original studies, special facilities for which are afforded by the collections of the Maryland Historical Society, the Maryland Episcopal Library of the late Bishop Whittingham, and by a newly instituted working collection in the Seminary of Historical and Political Science.—*Two hours weekly.*

3. Comparative Constitutional History, with special reference to the existing Constitutions of European States.

Once weekly, second half-year.

Dr. R. T. Ely.

4. Finance.

This course will deal at length with such practical topics as banking, paper money, monometalism, bi-metalism, and taxation.—*Thrice weekly, first half-year.*

5. Theory and Practice of Administration, with special reference to Civil Service Problems and Municipal Reform.

Thrice weekly, second half-year.

6. History of French and German Socialism.

Six lectures.

Note.—In addition to the regular work offered by the university instructors, various brief courses of class lectures upon special topics in Historical and Political Science may be given by lecturers, hereafter to be announced. A short course of public lectures on the Local Institutions of the United States will also be given by Dr. H. B. Adams at the Peabody Institute during the winter. Historical readings in Anglo-Saxon, German, and French, will be in progress through the year.

Graduates and advanced students are expected to have sufficient command of French and German to enable them to read historical and political works in those languages; persons deficient in this regard are advised to begin the study of those languages at once.

Graduates who so desire may take any portion of the following minor courses, but undergraduates will not be admitted to any of the advanced courses, except No. 6.

II. Minor Courses:

Dr. H. B. Adams, with assistance from Dr. J. F. Jameson.

1. Introductory Historical Course.

At matriculation, all students pass an examination in the general history of England and the United States. After this, (without taking up a full minor course), they may continue their historical studies by attending the following exercises:

Oriental History, Dr. Adams. *Weekly, first half-year.*

Classical History, Dr. Jameson. *Twice weekly, first half-year.*

Early European History, Dr. Jameson. *Twice weekly, second half year.*

This work may be counted, if desired, as part of the composite minor course (elsewhere described); and it will be required of all who follow the minor course in History as candidates for the Bachelor's degree.

Undergraduate students in classics, unless excused by the classical instructors, are expected to follow the exercises in Classical History above mentioned.

2. Minor Course in History.

(*a*) The Italian Renaissance and the German Reformation.

Five hours weekly, first half-year.

(*b*) Modern Absolutism and Revolution.

Five hours weekly, second half-year.

Dr. R. T. Ely.

3. Minor Course in Political Economy.

(*a*) Principles of Political Economy.

Five hours weekly, first half-year.

It is desirable that students who propose to follow this course should previously read one of the following manuals: Cossa's *Guide to the Study of Political Economy*; Rogers' *Manual of Political Economy*; or Mrs. Fawcett's *Political Economy for Beginners.*

(*b*) Historical Systems of Political Economy.

Five hours weekly, second half-year.

Note.—A Minor course in Historical and Political Science may be formed by combining a half-year's work in History with a half-year in Political Economy, together with the production of three essays, which shall be subject to the criticism and approval of the instructor in English. A Major course in Historical and Political Science comprises a full year in History and a full year in Political Economy, together with the production of six acceptable essays, and successful examination upon such courses of outside reading as may be prescribed in individual cases.

III. Historical and Political Science Association.

This will be a monthly meeting of advanced students of Historical and Political Science. Lawyers, resident graduates, and others who are interested in liberal studies, may become members of this Association. Papers of more general interest than those discussed at length in the seminary or class-room are here read, together with abstracts of the more important results of original investigation. Reviews are given of monographs, journals, and other recent literature of Historical and Political Science. Brief reports of the proceedings of the Association are printed in the University Circulars.

IV. Publication of Studies in Historical and Political Science.

With the opening of the next academic year will begin the publication of a series of University Studies in American Institutional History, with special reference to the Local Government and Economics of individual States of the Atlantic seaboard and of the Northwest. The publication will be at convenient intervals, in the form of separate reprints of studies contributed by members of the Association to the proceedings of learned societies in various parts of the country, together with such papers as may be printed from time to time by the University.

V. Library Facilities.

From the nature of the graduate-work pursued at the Johns Hopkins University, students are disposed to spend much of their time in original investigations and systematic reading in Baltimore Libraries. Aside from the opportunities afforded by the University Library, with its collection of special journals and works of general reference, there is the Seminary Library of Historical and Political Science, a branch of the main Library, but with distinctive aims: (1) the collection of the colonial laws, archives, and revised statutes of the seaboard States; (2) the gradual acquisition of the chief monuments of English jurisprudence, Saxon laws and charters, early compilations and the statutes of the Realm; (3) the texts of European and American treaties, with papers and diplomatic correspondence illustrating the same; (4) such books and special monographs as the actual work of the Seminary requires.

Other libraries frequently consulted by graduate students of Historical and Political Science are: (1) the Library of Congress, which is but an hour from Baltimore by rail and easily accessible; (2) the Library of the Maryland Historical Society in Baltimore, to which the whole mass of colonial and revolutionary archives of the State of Maryland will shortly be transferred from Annapolis; this Baltimore library already containing many portions of such original manuscript records, and the best existing collection of Maryland laws, together with complete sets of the Congressional records and other Government documents, also many rare pamphlets and broadsides, and files of newspapers covering the revolutionary and constitutional history of the United States; (3) the Library of the Baltimore Bar, containing the Law Reports of most of the States, journals, &c.; (4) the Peabody Library, numbering seventy thousand volumes and distinctively known as "a library of research", being especially rich in the proceedings of learned societies (*e. g.* European academies) and in the State, provincial, and municipal publications of America, England, France, Germany, Austria, and Italy—publications constituting the best original sources of Historical and Political Science; (4) the Maryland Episcopal Library, collected by the late Bishop Whittingham, and especially valuable for the original sources of Church History, patristic and scholastic literature, materials illustrating the progress of the Reformation, the planting of the Church and Free Schools, of Parishes and other old English institutions in Maryland and throughout the United States.

PHILOSOPHY, ETHICS, PSYCHOLOGY, AND LOGIC.

WORK OF THE PAST YEAR.

1881-82.

The courses in Philosophy, Ethics, Logic, etc., have been taken during the year by twenty-four students, of whom seventeen were advanced or graduate and seven undergraduate students.

The roll for the year included:

GEORGE S. MORRIS, A. M., *Lecturer.*
G. STANLEY HALL, Ph. D., *Lecturer.*
C. S. PEIRCE, S. B., *Lecturer.*
B. E. SMITH, A. M., *Assistant.*

E. S. Burgess, A. B., *Fellow.*
B. I. Gilman, A. M., *Fellow.*
O. H. Mitchell, A. M., *Fellow.*
E. H. Spieker, A. B., *Fellow.*
M. I. Swift, A. B., *Fellow.*
C. Ladd, A. B.

E. W. Davis, S. B.
A. H. Giles, A. M.
O. F. T. Hanser.
B. L. Hobson, A. M.
E. Ingle, A. B.
C. T. MacClintock, A. B.
W. D. MacClintock, A. M.
E. D. Preston, C. E.
H. F. Reid, A. B.
J. Sieber, A. B.
T. B. Veblen, A. B.

G. Bissing.
M. Fels.
M. Gregg.
T. J. Leftwich.
C. T. McDaniel.
P. M. Prescott.
L. B. Robinson.

Courses of lectures on the History of Greek Philosophy and on Ethics were given by Professor G. S. Morris, each three times weekly during the first half-year. A course of weekly lectures on Kant's Critique of Pure Reason was also given by Professor Morris.

A course of ten public lectures on Psychology was given by Professor Hall, with an average attendance of one hundred and ninety.

In Logic, an advanced class (meeting twice weekly) and an elementary class (meeting three times weekly) were instructed through the year by Mr. Peirce, who also conducted a series of Readings in Logic and gave a brief course of lectures on the Logic of Relatives.

The classes for the less advanced students were conducted by Mr. B. E. Smith: in Psychology, five times weekly, during the first half-year, and in Ethics and the History of Philosophy, five times weekly during the second half-year.

The Metaphysical Club has met monthly as heretofore for the presentation and discussion of papers. Papers have been read at these meetings by:

B. I. GILMAN, on propositions and the syllogism; on propositions called spurious; on theories of induction.

G. S. HALL, on E. von Hartmann.

O. H. MITCHELL, on the algebra of logic.

G. S. MORRIS, on English deism and the philosophy of religion.

C. S. PEIRCE, on J. S. Mill's logic.

B. E. SMITH, a review of Bowne's "Metaphysics"; on Wundt's theory of volition.

M. I. SWIFT, on consciousness and reality.

E. B. WILSON, a review of certain points in Murphy's "Habit and Intelligence."

PROGRAMMES FOR THE YEAR BEGINNING SEPTEMBER 19, 1882.

I. History of Philosophy, Ethics, etc.

PROFESSOR GEORGE S. MORRIS.

1. History of Philosophy in Great Britain.
   Three lectures weekly, first half-year.
2. Philosophical Seminary.
   For the study of selected texts, ancient and modern, relating to the science of knowledge. *Twice weekly, first half-year.*
3. Ethics, or the Science of Man.
   A study of selected texts, with especial reference to F. H. Bradley's *Ethical Studies. Four times weekly, first half-year.*
4. Hegel's Philosophy of History.
   (Sibree's Translation) *Weekly, first half-year.*
5. The Philosophy of Religion in its relation to Christianity.
   Eight public lectures, to be delivered in January, 1883.

II. Psychology, etc.

PROFESSOR G. STANLEY HALL.

6. Psychology.
   Wundt's *Physiologische Psychologie*, and Max Müller's *translation of Kant* will be used as a text-book basis. *Four lectures weekly, second half-year.*
7. Philosophy and Ethics.
   The chief themes and problems in Philosophy (including Ethics) since Locke will be considered by lectures, with limited selections from Bowen's *Modern Philosophy* and Porter's *Human Intellect* for text-book work. *Four times weekly, second half-year.*
8. Pedagogy.
   One public lecture weekly for eight or ten weeks.
9. Practical Work in Experimental and Observational Methods of Psychological Research.
   Hours to be later determined.

NOTE.—Courses 1, 2, 6, and 9 are intended only for advanced students or for undergraduates whose preliminary study of the sciences introductory to philosophy may have prepared them to enter upon advanced work. Courses 3, 4, and 7 are intended primarily for undergraduates.

Students who intend to pursue these courses are advised to read in advance one or more of the following works, with:

Course 1. Kuno Fischer, *Bacon und seine Nachfolger*; Ch. de Rémusat, *Histoire de la Philosophie en Angleterre*; T. H. Green, Introduction to his edition of *Hume's Treatise on Human Nature*; G. S. Morris, *British Thought and Thinkers*; major works of the leading British enquirers such as Bacon, Hobbes, Locke, Berkeley, Hume, Reid, Hamilton, the two Mills, Bain, Spencer, Lewes.
Course 2. Plato, *Theætetus*; Aristotle, *De Anima*; Berkeley, *Principles*; Hume, *Treatise*; Kant, *Critique of Pure Reason*; Fichte, *Science of Knowledge*; Hegel, *Logic*.
Course 3. Plato, *Republic*; Aristotle, *Ethics*; Calderwood, *Moral Philosophy*; Spencer, *Data of Ethics*; Kant, *Ethics*.
Course 4. Flint, *Philosophy of History*; R. Mayer, *Die philosophische Geschichtsauffassung der Neuzeit*.
Course 5. John Caird, *Introduction to the Philosophy of Religion*; E. Mulford, *The Republic of God*.
Course 6. Lotze, *Grundzüge der Psychologie*; Taine, *On Intelligence*; Ribot, *English Psychology*; Ribot, *La Psychologie Allemande Contemporaine*; Monck, *Introduction to the Critical Philosophy*.
Course 7 (for undergraduates). Ryland, *Handbook of Psychology and Ethics*; Mayor, *Sketch of Ancient Philosophy*.
Course 8. Quick, *Educational Reformers*; Farrar, *Essays on a Liberal Education*; Fitch, *Lectures on Teaching*; Latham, *The Action of Examinations*; either Diesterweg's, Beneke's, or Schrader's *Pedagogik*.

III. Logic.

MR. C. S. PEIRCE.

Mr. Peirce will lecture four times a week throughout the year. The course will embrace the following topics:

The Psychological and Metaphysical facts upon which the possibility of Logic rests.—Text: Mr. Peirce's papers, *The fixation of belief; How to make our ideas clear; Questions concerning certain faculties claimed for man; Further consequences of four incapacities; The validity of the laws of logic.* Here, as everywhere throughout the course, the doctrine of the text will receive improvements, and the subject will be further illustrated by the aid of other works.

Modern Formal Logic.—Text: De Morgan's *Syllabus of Logic*.

Boole's Logical Algebra.—Not merely the principles, but also the practice of this algebra will be rendered familiar, by the solution of numerous examples drawn from Boole, McColl, Miss Ladd, etc. Text: Schröder's *Operationskreis des Logikcalculs*.

The Logic of Relatives.—This subject will be treated in an elementary manner, so as to bring it within the capacity of the ordinary student. An entirely new general method of treating problems that involve relative terms will be developed. Text: Mr. Peirce's *Logic of Relatives, Algebra of Logic, Algebra of Relatives*, and a new paper.

Mathematical Reasoning.—The general nature of mathematical demonstration will be explained, the different varieties will be classified, and the particular use to which each can be put will be shown. The methods of mathematical research will be studied in the *history of multiple algebra*.

Theory of Probabilities.—The fundamental rules of the calculus will be discussed. Its practice will be illustrated by the solution of select problems, beginning with the simplest and proceeding to some of the most difficult. The theory of linear difference equations will be given. The method of least squares will be theoretically and practically treated. Text: Liagre's *Calcul des Probabilités, Boole's Calculus of Finite Differences, Ferrero's Metodo dei Minimi Quadrati.*

Inductive Reasoning.—A large part of the course will be devoted to this subject. Inductive and hypothetic inference will be considered as inverse forms of statistical deduction. The rules of these modes of inference will be deduced from the theory and set forth with great particularity, with many illustrations drawn from the history of the physical sciences. No effort will be spared to make this part of the course practically useful to the student. Text: Mr. Peirce, *On probable inference*.

The Nature of Scientific Reasoning, illustrated by the reading of Kepler's *De motibus stellæ Martis*.

Inquiry into the validity of Modern Conceptions of the Constitution of Matter.—Text: Meyer's *Kinetische Theorie der Gase*.

Relation of the New Theory of Logic to Philosophical questions.

Besides the lectures, Mr. Peirce will give private instruction in the different branches of logic to those who may desire to receive it.

The libraries of the University and the Peabody Institute are well supplied with books for the study of philosophy.

The Metaphysical Club for the study of logical, psychological, and philosophical matters will continue to hold monthly meetings.

The first volume of Logical Contributions, by members of the Johns Hopkins University, will be published early in the autumn.

Contents: The logic of the Epicureans, by Allan Marquand; On the algebra of logic, by Miss Ladd; On the algebra of logic, by O. H. Mitchell; On relative numbers, by B. I. Gilman; On probable inference, by C. S. Peirce.

RECENT APPOINTMENTS.

Appointments to FELLOWSHIPS for the next academic year have been made as follows:

William J. Alexander, (A. B., University of London, Eng., 1876) *Greek*.
Charles J. Bell, (A. B., Harvard, 1876; University of Munich) *Chemistry*.
James M. Cattell, (A. B, Lafayette, 1880) *Philosophy*.
Ellery W. Davis, (S. B., University of Wisconsin, 1879) *Mathematics*.
David T. Day, (A. B., Johns Hopkins, 1881) *Chemistry*.
William C. Day, (A. B., Johns Hopkins, 1880) *Chemistry*.
Henry H. Donaldson, (A. B., Yale, 1879) *Biology*.
William P. Durfee, (A. B., University of Michigan, 1876) *Mathematics*.
George S. Ely, (A, B., Amherst, 1878) *Mathematics*.
Alfred Emerson, (Ph. D., Munich, 1881) *Greek*.
William S. Fleming, (A. B., Davidson, 1878) *Greek*.
Arthur L. Frothingham, *Shemitic Languages*.
Benjamin I. Gilman, (A. B., Williams, 1872, and A. M., 1880) *Logic*.
Henry R. Goodnow, (A. B., Amherst, 1878) *Physics*.
Elgin R. L. Gould, (A. B., Victoria, Ont., 1881) *History*.
Arthur S. Hathaway, (S. B., Cornell, 1879) *Mathematics*.
William H. Howell, (A. B., Johns Hopkins, 1881) *Biology*.
Arthur L. Kimball, (A. B., Princeton, 1881) *Physics*.
Harry F. Reid, (A. B., Johns Hopkins, 1880) *Physics*.
Henry N. Stokes, (S. B., Haverford, 1878) *Biology*.

The persons below named have been nominated by the Academic Council for GRADUATE SCHOLARSHIPS:

Gustav Bissing, (A. B., Johns Hopkins, 1882) *Mathematics*.
James R. Duggan, (A. B., Mercer, 1877; M. D., Jefferson Medical, 1879) *Chemistry*.
James E. Keeler, (A. B., Johns Hopkins, 1881) *Physics*.
C. W. Emil Miller, (A. B., Johns Hopkins, 1882) *Greek*.
Charles A. Perkins, (A. B., Williams, 1879) *Physics*.
B. James Ramage, (A. B., Newberry, 1880) *History*.
Lewis T. Stevens, (A. B., Johns Hopkins, 1882) *Biology*.
Lewis W. Wilhelm, (A. B., Johns Hopkins, 1880) *History*.

Other appointments have recently been made in the University as follows:

Fabian Franklin (Ph. D., Johns Hopkins, 1880; F.)—Associate in Mathematics.
R. T. Ely (Ph. D., Heidelberg, 1879)—Associate in Political Economy.
J. W. Bright (Ph. D., Johns Hopkins, 1882; F.)—Instructor in German.
J. F. Jameson (Ph. D., Johns Hopkins, 1882; F.)—Instructor in History.
E. H. Spieker (Ph. D., Johns Hopkins, 1882; F.)—Instructor in Latin and Greek.

C. R. Hemphill, A. M., lately a Fellow here and now Professor in the Southwestern Presbyterian University, has been appointed a Professor in the Theological Seminary, Columbia, S. C.

G. F. Nicolassen, Ph. D., lately a Fellow and Assistant in Greek and Latin here, has been appointed Professor of Ancient Languages in the Southwestern Presbyterian University, Clarksville, Tenn.

W. S. Pratt, A. M., lately a Fellow here and recently connected with the Metropolitan Museum of Art, New York, has been appointed Instructor in Ecclesiastical Music in the Theological Seminary, Hartford, Conn.

Josiah Royce, Ph. D., lately a Fellow here and afterwards Instructor in the University of California, has been appointed an Instructor in Philosophy in Harvard University.

Henry Sewall, Ph. D., a former Fellow and Associate in Biology here, has been appointed Professor of Physiology in the University of Michigan.

W. I. Stringham, Ph. D., lately a Fellow here and recently holding the Parker Fellowship of Harvard University, has been appointed Professor of Mathematics in the University of California.

J. H. Wheeler, Ph. D., lately a Fellow here and now Professor of Latin in Bowdoin College, has been appointed Professor of Greek in the University of Virginia.

DEGREES CONFERRED, 1882.

Doctors of Philosophy.

The degree of Doctor of Philosophy was conferred on the following persons:

1. **James W. Bright**, of Lock Haven, Pa., A. B., Lafayette College, 1877, and A. M., 1880. His principal study was the Teutonic Languages, the subordinate, Sanskrit. He submitted a thesis entitled "A Discussion of the Verbal forms in King Alfred's West-Saxon Version of Gregory's *Cura Pastoralis.*"

2. **J. Franklin Jameson**, of Amherst, Mass., A. B., Amherst College, 1879. His principal study was History, the subordinate, Political Economy. His thesis on "The Origin and Development of the Municipal Government of New York City," is in course of publication in the *Magazine of American History.*

3. **Mitsuru Kuhara**, Tsuyama, Japan, S. B., University of Tokio, 1877. His principal study was Chemistry, the subordinate, Mineralogy. His thesis on the "Oxidation of Nitrometaxylene," has been published, in modified form, in the *American Chemical Journal.*

4. **Robert W. Mahon**, of Baltimore, C. E., Lehigh University, 1876. His principal subject was Chemistry, his subordinate, Physics. His thesis on "Some Investigations on the Benzyl-derivatives of the Sulphamides of Metaxylene," will be published in modified form, in the *American Chemical Journal.*

5. **Oscar H. Mitchell**, of Marietta, Ohio, A. B., Marietta College, 1875, and A. M., 1878. His principal subject was Mathematics, the subordinate, Logic. His thesis, entitled "Some Theorems in Numbers, with a Generalization of Fermat's and Wilson's Theorems," has been published in the *American Journal of Mathematics.*

6. **George F. Nicolassen**, of Baltimore, A. B., University of Virginia, 1879, and A. M, 1880. His principal subject was Greek, the subordinate Latin. His thesis on "The Articular Infinitive in Xenophon," will be prepared for publication.

7. **William A. Noyes**, of Grinnell, Iowa, A. B., Iowa College, 1879. His principal subject was Chemistry, the subordinate, Physics. His thesis "On the Protection from Oxidation of a Group containing two Carbon-Atoms," will be published, in modified form, in the *American Chemical Journal.*

8. **Chase Palmer**, of Baltimore, A. B., Johns Hopkins University, 1879. His principal subject was Chemistry, the subordinate, Mineralogy. His thesis "On the Sulphocinnamic Acids" will appear, in modified form, in the *American Chemical Journal.*

9. **Edward H. Spieker**, of Baltimore, A. B., Johns Hopkins University, 1879. His principal subject was Greek, the subordinate subjects Latin, Sanskrit, and Hebrew. His thesis "On the so-called Genitive Absolute and its use, especially in the Attic Orators," will be prepared for publication.

Bachelors of Arts.

The degree of Bachelor of Arts was conferred on the following persons:

1. **William H. Adkins**, of Easton, Md., who received his previous training at the Easton (Md.) Classical School, and has finished major courses in History and Latin, and minor courses in German, Greek, and Physics.

2. **T. Alexis Berry**, of Baltimore, who pursued his preliminary studies under Dr. Robert Atkinson, and has finished major courses in German and History, and minor courses in Chemistry, Physics, and French.

3. **Gustav Bissing**, of Baltimore, a former student of the City College, who has finished major courses in Mathematics and Physics, and minor courses in Chemistry, Logic, and German.

4. **Walter B. Clarkson**, of Baltimore, who after graduating at the City College, matriculated in this University at its opening in 1876, and pursued his studies here with the highest promise. He is recommended for his degree *extra ordinem.* He was compelled by failure of health to go to the South before completing the courses he had undertaken; and has for several years been principal of the High School, Jacksonville, Fla. The Academic Council has satisfied itself of his continued advancement in liberal studies.

5. **Hermann L. Ebeling**, of Catonsville, who received his preliminary training at Overlea School, Catonsville, and has completed major courses in German and History, and minor courses in Greek, Latin, and Physics.

6. **Louis Garthe**, of Baltimore, who graduated at the City College, in 1880, and has finished major courses in German and French, and minor courses in Chemistry, English, Mineralogy, and Latin.

7. **Edward Ingle**, of Baltimore, a former student of the City College, who has finished major courses in Greek and Latin, and minor courses in German, History, and Physics.

8. **Richard F. Kimball**, of Baltimore, who pursued his preliminary studies under Mr. C. P. Grady, and has finished major courses in History and Latin, and minor courses in French, German, and Chemistry.

9. **Gustav A. Liebig, Jr.**, of Baltimore, who pursued his preliminary studies under Dr. E. Deichmann, and has finished major courses in Mathematics and Physics, and minor courses in Chemistry, Biology, and French.

10. **C. W. Emil Miller**, of Baltimore, a graduate of the City College in 1880, who has completed major courses in Greek and Latin, and minor courses in French, Physics, and German.

11. **James Page**, of Baltimore, a former student of the City College, who has finished major courses in German, Physics, and Mathematics, and minor courses in French, and Latin.

12. **Albert G. Palmer**, of Baltimore, who received his preliminary training at the Friends' High School, and has completed major courses in Chemistry and German, and minor courses in English, French, and Physics.

13. **Robert M. Reese**, of Baltimore, who received his preliminary training at the Friends' High School, and has completed major courses in French and German, and minor courses in Latin, History, and Physics.

14. **Lewis T. Stevens**, of Baltimore, a former student of the City College, who has finished major courses in Chemistry, Biology, and German, and minor courses in Physics and English.

15. **Herbert T. Tiffany**, of Baltimore, who pursued his preliminary studies under Mr. S. E. Turner, and has finished major courses in History and Latin, and minor courses in French, German, Greek, and Physics.

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PROCEEDINGS OF UNIVERSITY SOCIETIES.

Abstracts of the More Important Papers Read at Recent Meetings.

Scientific Association.

May meeting.

On the Geometrical Interpretation of Certain Formulæ in Elliptic Functions, by Professor A. Cayley.

I have given in my Elliptic Functions expressions for the sn² of $u+\frac{1}{2}k$, $u+\frac{1}{2}ik'$, $u+\frac{1}{2}k+\frac{1}{2}ik'$; but it is better to consider the dn², sn², cn² of these combinations respectively, and to write the formulæ thus:

$$\begin{aligned}
\mathrm{dn}^2(u+\tfrac{1}{2}k) &= k'\frac{\mathrm{dn}u-(1-k')\mathrm{sn}u\,\mathrm{cn}u}{\mathrm{dn}u+(1-k')\mathrm{sn}u\,\mathrm{cn}u}, = k'\frac{1-k^2x-(1-k')y}{1-k^2x+(1-k')y};\\
\mathrm{sn}^2(u+\tfrac{1}{2}ik') &= \frac{1}{k}\,\frac{(1+k)\mathrm{sn}u+i\,\mathrm{cn}u\,\mathrm{dn}u}{(1+k)\mathrm{sn}u-i\,\mathrm{cn}u\,\mathrm{dn}u}, = \frac{1}{k}\,\frac{(1+k)x+iy}{(1+k)x-iy};\\
\mathrm{cn}^2(u+\tfrac{1}{2}k+\tfrac{1}{2}ik') &= \frac{-ik'}{k}\,\frac{\mathrm{cn}u-(k+ik')\mathrm{sn}u\,\mathrm{dn}u}{\mathrm{cn}u+(k+ik')\mathrm{sn}u\,\mathrm{dn}u},\\
&= \frac{-ik'}{k}\,\frac{1-x-(k+ik')y}{1-x+(k+ik')y};
\end{aligned}$$

where in the last set of values x, y are used to denote sn^2u and $\mathrm{sn}u\,\mathrm{cn}u\,\mathrm{dn}u$ respectively; and the formulæ are thus brought into connexion with the cubic curve $y^2=x(1-x)(1-k^2x)$. The curve has an inflexion at infinity on the line $x=0$; and the three tangents from the inflexion are $x=0$, $x=1$, $x=\frac{1}{k^2}$, touching the curve at the points $x, y=(0, 0)$, $(1, 0)$, $\left(\frac{1}{k^2}, 0\right)$ respectively: hence these points are sextactic points. We may from any one of them, for instance the point $(0, 0)$, draw four tangents to the curve, $(1+k)x+iy=0$, $(1+k)x-iy=0$; $(1-k)x+iy=0$, $(1-k)x-iy=0$, where the first and second of these lines form a pair, and the third and fourth of them form a pair, viz: the two tangents of a pair touch in points such that the line joining them passes through the point of inflexion: in particular for the first mentioned pair the equation of the line joining the points of contact is $1+kx=0$. The linear functions belonging to a pair of tangents are precisely those which present themselves in the formulæ, thus if $T_1=(1+k)x+iy$, $T_2=(1+k)x-iy$, the second of the three formulæ is $\mathrm{sn}^2(u+\frac{1}{2}k)=\frac{1}{k}\,\frac{T_1}{T_2}$; and the other two formulæ correspond in like manner to pairs of tangents from the sextactic points $\left(\frac{1}{k^2}, 0\right)$, and $(1, 0)$ respectively. The formulæ are connected with the fundamental equations expressing the sn, cn, dn as quotients of theta-functions.

On Sinapine, a Constituent of Mustard; a preliminary notice, by R. Dorsey Coale.

A full account of this investigation will be published in the *American Chemical Journal.*

On Certain Recent Observations relating to the so called "Granules" of the Solar Surface, by C. S. Hastings.

Philological Association.

May meeting.

The Dialectical Peculiarities of the Kentish Charters, by H. Wood.

The following seven Charters were considered in this paper: 1. *Alfred Aldorman*, 871–889 A. D.; 2. *Wulfred, Oswulf and Beornðryð*, 805–810; 3. *Eadwald*, 830–831; 4. *Ealburh*, 831; 5. *Lufa*, 832; 6. *Abba*, 835; 7. *Badanoð*, 837. The dates are Kemble's, as revised by Thorpe. No. 1 was tested by all the laws of vowel change that apply, and was found to agree closely in dialect with the Interlinear Version of the Psalter (ed Stevenson 1843–47 for the Surtees Soc.). Both differed in a marked manner, and in the same particulars, from the Kentish Glosses (Vesp. D 6), and, in the absence of vocalized ȝ, from the Epinal Glosses. The conclusion was reached, in opposition to Sweet (Past. Care xxi., and "Dialects," 554), that the Charter is neither West-Saxon nor Kentish, but rather Northumbrian-Mercian. Sievers' recent statement (*Ags. Gram.* 2), that the Psalter is closely related to Northumbrian, partly confirms this result. No. 2, tried by the same tests, exhibited many old forms, but the same conclusion was reached, in opposition to Zeuner (*Spr. des Kent. Psalters* 8). Nos. 3, 4, and 5 were found to be decidedly Kentish. No. 7 was added to the Kentish list on account of the instances of vocalized ȝ it exhibits, but neither 6 nor 7 show unmixed Kentish forms of any period. They are evidently older than 3, 4, and 5.

The handwriting of the Charters, as shown in the Brit. Mus. Facsimiles of all except the first, was then examined, and such historical and external evidence was brought forward as could be collected from Synodal decisions, and the comparison of names affixed to Mercian Charters. The results were not given as direct proof of dialect, but as tending to show—first, that many Charters relating only to Kentish matters were doubtless written in a more Northern dialect, and second, that No. 2 of the Charters above considered was of that number.

On the Beginnings of the Athenian Hegemony, by C. D. Morris.

In this paper an attempt was made to show that, in order to controvert the conclusion of Kirchhoff (*Hermes*, 1876), as to the comparatively late adhesion to the Attic league of the cities of the West and South-west coast of Asia Minor, it was not necessary, with Steup (*Rhein. Mus.*, 1880), to do violence to the text of our authorities. It was argued that (1) it is under the circumstances unwarranted to infer that the Ionic cities held aloof or were excluded from the league because we do not find specific mention of the details of their accession; and (2) that the argument advanced by Kirchhoff to prove in a positive way the absence of Athenian authority from the Ionic coast involves a practical anachronism; since it assumes at the date of the flight of Themistocles a strictness and minute rigor in the administration of the Attic league, which is inherently improbable, and of which we have no evidence till a considerably later time. On the other hand, it was pointed out that the reasons which induced Steup to tamper with the text of Herodotus and Thucydides are founded only upon a self-imposed obligation to interpret the words *ξύμμαχοι* and *κατὰ τὸ ξυγγενές* in a rigid and pedantic way, without any evidence that the writer intended that his language should be so pressed. At the conclusion of the paper attention was called to the statement of Diod. Sic., xii. 34, that on the day *before* the battle of Mycale, Leotychides spoke of the battle of Platæa as already fought and gained. It was shown that this cannot be a mere confusion with the *φήμη* mentioned by Herodotus (ix. 100), because Diodorus gives an account parallel with this in c. 35. When he does so, he calls attention to the surprising character of the rumour, and offers a rationalising explanation of it. It was argued, therefore, that it is not credible that he could have thought it necessary thus to account for an apparent miracle on the day of the battle, and yet have intended to narrate casually and without remark what would be a yet more miraculous, because prophetic, statement as made on the day before. It was consequently suggested that in c. 34, Diodorus, or the authority from whom he copied, wrote *νενικηκότες ἐν* Πλαταιαῖς when he intended to write *ἐν Σαλαμῖνι*, which would make the assertion exactly consonant with the facts.

Notes on a German Passion Play, by William H. Carpenter.

The subject of these notes was the MS. of an unpublished Passion Play belonging to the private library of President White, of Cornell University. The MS. was purchased for its present owner at the sale of the library of Sir F. Madden, but how or when it came into his possession is not known; it contains neither the place nor the time of its origin, but merely bears the title written on the outside of the cover: *Registrum ipsius Ludus designantis Cenam dum ac eius passionem una cum eiusdem designantis resurrectionem demonstratione.* The MS. is in form a columnar quarto of 68 leaves, written on paper and bound in parchment. The chirography is throughout good and distinct, but in several different hands; the first is the best and plainest and recurs at intervals throughout the MS. The stage directions are written in red and are throughout in Latin. The play is divided into three parts, which were played respectively on Holy Thursday, Good Friday, and Easter Sunday; each part is opened by the precursor who announces succinctly the scenes to be represented and the course of the play: on the third day two angels go before the precursor. The first day's performance is contained in the MS. on pp. 1ᵃ–16ᵇ: it begins with the complaint of the Jews who were driven by Jesus out of the temple with a scourge, and proceeds with the deliberation of the Jews concerning Jesus, the washing of feet and the last supper, the questions of the disciples about the betrayer, Judas' bargain with the chief priest, Jesus with the disciples in Gethsemane, his seizure by the Jews, Jesus before Caiaphas, mocking by the Jews and the decision to conduct him to Pilate —The second day is contained on pp. 17^a–42^b: it shows Pilate in his office of governor, the proceedings before him, the crucifixion, the lament of Mary, the removal from the cross and the burial. Finally the third day is contained on pp. 43^a–62^b: it begins with the conference respecting a guard of soldiers at the grave and the bargain with them about their reward, then the conversation of the soldiers with each other at the grave, the resurrection, the descent into hell, Mary Magdalene at the grave with Jesus, Peter and John going to and at the grave, the soldiers at the grave after the resurrection, Caiaphas informed, the deliberations of the Jews and the instructions to the soldiers to say that one of the disciples had stolen the body, and finally the declaration of one of the soldiers to the people to this effect. The *dramatis personæ* of the first day's performance are then given on p. 63^a, of the second day on p. 64^a, of the third day on p. 64^b; lastly the names of the persons taking part in the play are given on pp. 68^a-68^b—these are also throughout the MS. written in red opposite the parts to be said or sung; accompanying the parts to be sung—usually Latin—are, in most cases, the notes. The play is doubtless in the main original, but bears, nevertheless, a marked resemblance to other passion plays, which is, however, a natural consequence of the exact identity of source and dramatic aim. Especially is this true of the Marien-Klage, which is made up of Latin songs thinly interlarded with German dialogue. The language of the MS. shows upon the most cursory examination its South German origin; its dialectic peculiarities, furthermore, prove it to be Bavarian-Austrian,—it was probably written a little previous to the year 1500. Its most marked phonetic characteristics are:

The usual retention of Ohg. *p* in anlaut: *pin*, *pluet*, *perg*, *verpietten*, *geporen*, *untzerprochen*. The usual apocopation of *e* in auslaut: *pott* (*bote*), *pald* (*balde*), *laydt* (*leide*), *zue* and *zu*.

For Mhg. *uo* the MS. has throughout *ue*: *suechen*, *guett*, *fuess*, *rueffl*, *mueshauss*.

For Mhg. *ei* the MS. has throughout *ai*: *payde*, *ain*, *kain*, *schways*, *getzaygt* (*y* interchanges with *i* both when alone and as a member of a diphthong).

For Mhg. *î*, *û*, *iu*, *ou* the MS. has as in Nhg. *ei*, *au*, *eu*, *au*.

W occurs for *b* in *offenwar*, *offenwarlich*.

Historical and Political Science Association.

May meeting.

Parish Institutions of Maryland, by Edward Ingle.

By an Act of Assembly passed in 1692 the Church of England was established in Maryland. The Province was divided into thirty-one parishes from ten to eighty miles long, and Vestries were chosen. The Act of 1702 remedied the imperfections of former Acts, and was the basis for church government until the revolution.

In each parish the freeholders chose six *select* Vestry-men and two Church Wardens. The Vestry, composed of "sober and discreet" persons, was the guardian of parish property and morals. The Vestry-house was usually the first parish building. There the Vestry-men met and transacted the business of the parish. When there was no incumbent, the goods in the Vestry's possession were expended in building or repairing churches, or in buying and stocking glebes. The churches were generally built of wood, with little or no attempt at ornamentation. At one time the Vestry chose counters of tobacco for the parish, and nominated inspectors of tobacco, out of which nominees the Governor made his appointments. When the tax was imposed upon bachelors, the Vestry made out the list and sent it to the sheriff. Adulterers, &c., were presented for trial to the County Courts by the Vestry of the parish where the offence was committed. Vestry-men and Church Wardens could commit profane and drunken persons to the stocks or whipping post. The special duties of Wardens were to care for the church linen and plate, and to provide the elements for the communion. They also kept order in and around the churches, and reported the state of the parish to the Commissary at his visitations.

All taxables were assessed forty pounds of tobacco yearly for the support of the clergy. From his own salary the minister had to pay one thousand pounds of tobacco a year to a parish-clerk, whose special duties were to read responses and give out the hymns. The minister was licensed by the Bishop of London and inducted by the Governor. The Vestry had no power in the choice of a rector. The people were opposed to the parish system, and efforts were made to abolish it. The minister's salary was lessened and stringent laws were passed for the punishment of ecclesiastical offenders. This feeling of discontent contributed not a little to the opposition against the mother country before the revolution. During that struggle the Established Church lost ground. Many of the clergy left the country, and those who remained were poorly supported. In 1779 a Vestry Act was passed by which church property was vested in select vestries. It was found that the provisions of this Act did not meet the wants of the Protestant Episcopal Church, so in 1798 a new Act was passed. This is the basis of the present parish system, though some changes have been made. In 1802 the powers of Justices of the Peace were taken from the Wardens. The Vestries are now governed by the provisions of their charters, which generally conform to the laws of the Diocesan Convention.

The Growth of Internationalism, by Albert Shaw.

Jeremy Bentham from one ethical stand-point, Immanuel Kant from an opposite one, projected a world-organization for the maintenance of perpetual peace. Every school of religion, of politics, and of philosophy, has at one time or another given expression to the universal hope for world-peace and international union. We may be certain, however, that these ideals will never be attained except by those processes of slow development which have built up all systems of municipal law and constitutional government. Any perfect system must be long preceded by undercurrents of tendency, isolated points of contact, fragments of organization, and a hundred half-concealed forces of assimilation. If a posterity not many generations remote is to enjoy international government, that system must be the result of causes now at work,—its history must already have begun.

Proposed schemes have generally concurred in providing for a Code of Law, a Judicial Tribunal, and a Legislature. It will be convenient to use this division in a discussion of the subject. In form, an international code would be an extended treaty It would comprise a systematic statement of the whole body of public law. At present that law is chaotic and confused; codification would enhance its efficiency. Public law is voluntary; its only sanction is found in the general recognition. It cannot, then, be expected that the whole body of law will find an even and simultaneous development. Some principles gain acceptance before others have come within the horizon of the world's consciousness. Before our code as a whole can be adopted, its parts must one after another be evolved, here a chapter and there a page. To show that it has for centuries been so developing, many historical illustrations were cited. The labors of Francis Lieber, Dr. Bluntschli, David Dudley Field and others, were adverted to, and it was held that codification would soon be feasible.

A tribunal for the determination of great public questions is a pressing need. Bulmerincq's plan for a maritime prize court was detailed. Arbitration was also discussed, and the plans of David Dudley Field and of A. H Stoiber, for the erection of standing Courts of Arbitration, were rehearsed The resolutions of Parliament, of the Congress of the United States, and of continental legislatures, favoring arbitration, were cited as indicating the tendency of the times. The Supreme Courts of the United States and of Canada were mentioned as international in a limited sense. The comparative study of jurisprudence, the growth of a law-abiding spirit, and the radical improvement in the moral character of war, are forming a soil which can support an international court of law.

The idea of an international legislative body is already more than a dream. A historical sketch of European diplomatic Congresses and Conferences, in their capacity as authors of positive international law, was rapidly drawn. It was maintained that all federal legislative bodies, such as the American Congress or the German Reichstag, are the outgrowth of diplomatic beginnings, and that a European legislature, holding periodic sessions and empowered to enact public law, might reasonably be expected to grow out of diplomatic conventions, such as the Congresses of Vienna, Paris, and Berlin.

Even more significant as showing the drift of our time towards internationalism, are such gatherings as Congresses of Electricians and Geographers, meetings of the Evangelical Alliance, Monetary Conferences, the societies for the improvement of international law, and great world fairs like those at Vienna, Philadelphia, Paris, and Atlanta.

Townships and Schools in New Jersey, by O. A. Johnson.

The principal officers elected at an annual town meeting in New Jersey are a clerk, assessor, collector, and three or more judicious freeholders, who decide all disputes in regard to assessments, also two "chosen freeholders," who represent the township upon the county-board, two surveyors of highways, and overseers of road districts. Five chosen and judicious freeholders constitute the township committee, who examine and report to the annual town meeting the accounts of the township.

The first school law in New Jersey was passed in 1693, when it was provided that, if a majority of the inhabitants in any town were in favor of having free public schools, all were obliged to pay their school-tax. Schools were thus instituted by local option. In 1817 a public school fund was created, which has continually increased, so that at present, with a two mill school-tax upon all property, the common schools of New Jersey are upon good foundations.

Sources of the Institutional History of Pennsylvania, by E. R. L. Gould.

Review of Edward Spencer's History of Manufactures in Maryland, by E. W. Bemis.

Metaphysical Club.

April meeting.

On Propositions and the Syllogism, by B. I. Gilman.

In this paper general terms were considered as of two kinds: the intensively definite, connoting a fixed group of qualities, and the extensively definite, denoting a fixed group of objects. Six kinds of propositions involving such terms were described, viz: Verbal Propositions, asserting that two groups of qualities have components in common (Propositions of Definition) or that two groups of objects have components in common (Propositions of Division); and Real Propositions, asserting (1) that two groups of qualities are sometimes found in the same object (Propositions of Concomitance), or (2) that two groups of objects possess qualities in common (Propositions of Resemblance), or (3) that, in some cases, components of a group of objects possess a group of qualities (Propositions of Possession), or (4) that, in some cases, components of a group of qualities are common to a group of objects (Propositions of Inherence). Each of these propositions may be denied as well as asserted, the affirmative species being particular and the negative universal; and each of these latter gives rise by negating the terms in all ways to four forms. Three of the six kinds of propositions, those of Definition, Resemblance, and Inherence, are the reciprocals of the other three, referring to qualities as the latter do to objects; and take a negative similarly reciprocal to the ordinary negative. The syllogistic of these forty-eight propositions consists of arguments following either the particular or universal type of ordinary syllogism, and in the case of Real Propositions consists of twelve such arguments, six universal and six particular.

From Propositions of Concomitance, signifying the assertion or denial of the existence of a class, a complex propositional system was developed containing propositions asserting or denying more than one class. Such a system contains seventy-five varieties, or eighty if the possibility is allowed of the non-existence of the Universe of Discourse. These may be reduced to eighteen types, or twenty on the supposition just made. For the expression of these propositions a special notation was employed. The syllogistic of these eighteen types embraces thirty-four forms of complex argument. A similar complex syllogistic may be developed from either one of the other five kinds of propositions named above.

Remarks on the above paper, by C. S. Peirce.

Mr. Peirce remarked that the propositional system of De Morgan supposes the universe of things to be limited (in this sense, that there is some logically possible combination of characters which does not occur in any existing thing), but supposes the universe of characters to be unlimited (in the sense that there is no aggregate of things which do not possess some common mark). Mr. Peirce undertook to show what propositional system is necessary in case both universes are permitted to be limited, so that nothing of a general nature can be assumed respecting the relations of things and of characters. There will, in the first place, be *universal* propositions asserting that two classes of objects have no common breadth, and *particular* propositions asserting that two classes of objects have a common breadth. These are purely *extensive* propositions. There will also be purely intensive, or (better), *comprehensive* propositions, asserting that two groups of marks have or have not a common depth.

Next there will be propositions asserting some relation between a group of things and a group of marks. These will be of twelve intransmutable species, as follows:

First, *affirmative* propositions, asserting the possession of characters by things.

a. Every one of a named class of things is said to possess every one of a named group of characters.

β. Some one or more (without saying what), of a class of things is said to possess every one of a group of characters.

γ. Every one of a named group of characters is said to be possessed by some one or other of a named class of things. [*γ* follows strictly from *β*].

δ. Some one or more (without saying what), of a named group of characters is said to be possessed by every one of a named class of things.

ε. Every one of a class of things is said to possess some one or other of a named group of characters. [*ε* follows from *δ*].

ζ. Some one of a class of things is said to possess some one of a group of characters.

Second, six *negative* propositions, denying the possession of characters by things will correspond exactly to the affirmative forms.

These may be called propositions of the *first* order, because the relative term "possessing as a character" enters into them once.

A proposition of the second order will be such as this. "Every *S* possesses every character not possessed by some *T*." There will be eighty-eight species of this order. The number of orders is infinite.

Propositions of even orders are evidently of two families, the *extensive* and the *comprehensive.*

In immediate inferences, the order of the conclusion agrees with that of the premise in respect to being even or odd; and in simple immediate inference the order is either unchanged or increased or diminished by two. An immediate inference from a universal to a particular proposition is impossible.

In syllogisms, it is necessary and sufficient that there should be a distributed middle term, and the order of the conclusion is the sum of the orders of the premises. Of course, immediate inference from the conclusion is often possible. [What De Morgan calls spurious propositions may be inferred from two premises having an undistributed middle].

The treatment of the subject is greatly facilitated by the application of the algebra of relatives. For this purpose, the propositions may be so transformed as to make 1 or "what is identical with" in every case the subject; and only one copula will be necessary, owing to the terms being identified with relatives. To obtain an inference the premises are to be relatively multiplied together, and then all inferences conform to one or other of these formulæ:—

$$(a \dagger b)c \prec a \dagger bc$$
$$a(b \dagger c) \prec ab \dagger c.$$

The dagger here denotes the operation of "relative addition." If denote "lover of" and *s* "servant of," then *ls* denotes "lover of a servant of," and $l \dagger s$ denotes "lover of everything but a servant of."

A universal proposition stating that one relation is a special case of another is most naturally written in the form $l \prec s$, which particular example means that to be a lover is to be a servant. But we have the general formulae

$$1x = x \qquad x \dagger \mathfrak{n} = x$$
$$x1 = x \qquad \mathfrak{n} \dagger x = x$$

when $\mathfrak{n}$ means 'not,' or 'other than.' By means of these formulae we bring the proposition $l \prec s$ into the forms

$$1l \prec s \qquad l \prec s \dagger \mathfrak{n}$$
$$l1 \prec s \qquad l \prec \mathfrak{n} \dagger s.$$

We now apply one of the rules for transposition. These rules are, first, that the proposition $xy \prec z$ is equivalent to $\breve{\bar{z}}x \prec \breve{\bar{y}}$ and to $y\breve{\bar{z}} \prec \breve{\bar{x}}$ (where the straight line over a term *negatives* it and the curved line *converts* the relation), and second, that the proposition $x \succ y \dagger z$ is equivalent to $\breve{\bar{z}} \prec x \dagger \breve{\bar{y}}$ and to $\breve{\bar{y}} \prec z \dagger \breve{\bar{x}}$. The application of these rules to the four forms just given yield the following equivalents of $l \prec s$:

$$\breve{\bar{l}}s \prec \mathfrak{n} \qquad 1 \prec \breve{\bar{l}} \dagger s$$
$$\breve{\bar{s}}l \prec \mathfrak{n} \qquad 1 \prec s \dagger \breve{\bar{l}}.$$

A particular proposition asserting that there is a pair of objects such that the first is at once in two relations to the second, cannot, in general, be expressed by the algebra of *dual* relatives without the use of a negative copula. But this can be done in the special case in which the relatives have every object in the universe for correlate to each relate. Now a non-relative term such as 'man' may be considered as a relative term of which the relates are the different men and the correlates all objects in the universe; so that whatever is a man is a man for every object in the universe. With that understanding, if *m* denote 'man' and *h* 'honorable,' we can express that some man is honorable by writing $1 \prec \breve{m}h$ or $1 \prec \breve{h}m$.

Suppose now that we have given the two premises $1 \prec a \dagger b$ and $1 \prec \breve{\bar{b}} \dagger c$. Multiplying them we have

$$1 \prec (a \dagger b)\,(\breve{\bar{b}} \dagger c).$$

But

$$(a \dagger b)\,(\breve{\bar{b}} \dagger c) \prec a \dagger b\,(\breve{\bar{b}} \dagger c) \prec a \dagger b\breve{\bar{b}} \dagger c.$$

Now we have the general formula

$$b\breve{\bar{b}} \prec \mathfrak{n}.$$

Thus we infer

$$1 \prec a \dagger \mathfrak{n} \dagger c.$$

But

$$a \dagger \mathfrak{n} = a,$$

so that we have

$$1 \prec a \dagger c,$$

which is the syllogistic conclusion. In like manner from the two premises $1 \prec a \dagger b$ and $1 \prec \breve{\bar{b}}c$, we get

$$1 \prec (a \dagger b)\,\breve{\bar{b}}c$$

and thence, successively,

$$1 \prec (a \dagger b\breve{\bar{b}})\,c$$
$$1 \prec (a \dagger \mathfrak{n})\,c$$
$$1 \prec ac$$

which is the syllogistic conclusion.

But from the two premises $1 \prec ab$ and $1 \prec \breve{\bar{b}}c$ we only get

$$1 \prec (ab)\,(\breve{\bar{b}}c)$$
$$1 \prec a\mathfrak{n}c$$

which is a spurious proposition.

The extension of this method to the syllogistic of the higher orders of propositions affords no difficulty.

May meeting.

Consciousness and Reality, by M. I. Swift.

The aim of physical science is to account for all things by means of mechanical principles. The question arises whether there is any limit to the application of this method. Formerly there was a gulf between the activity of organic and inorganic matter, but it is now believed that this has been practically bridged over. The gulf between consciousness and the physical world still remains. Can these also be united upon physical principles? Clifford's "mind-stuff" theory is typical of various recent attempts that have been made with this end in view. Consciousness is regarded as made up of many "elementary feelings" not in themselves conscious. These feelings are the ultimate reality, and are termed "mind-stuff." "Mind-stuff is the reality which we perceive as matter." By this theory reality is placed beyond consciousness, and the physical is treated as phenomenal. The real nature of consciousness is therefore not explained, and we have no warrant for applying the laws of external phenomena to it, so that the supposed bridge turns out to be illusory. The true importance of the theory is its indirect reduction of the mechanical to the psychical, instead of the reverse, in its attempt to connect the two.

Efforts more strictly physical in their nature have likewise failed to explain consciousness mechanically, but science does not pronounce such an explanation impossible. In opposition to this view there is a tendency to uphold the theory of "vital principles," and "forces" acting upon matter from without. Not only is it impossible to prove this, but nothing would be gained by its proof, for we should be plunged into the difficulties of a clearly established dualism. The true problem rests upon a wider basis. The error of supposing that consciousness can be physically explained arises largely from the habit of regarding it as of like nature with physical phenomena. Consciousness does not belong to the physical world, in that it cannot be sensibly perceived and is not a force. It cannot act upon physical forces nor they upon it, wherefore we may conclude that it could not be produced by such forces. There are, then, two realities, consciousness and the physical world. Reason, however, demands that one ultimate and all-embracing reality be found. Since consciousness cannot be constructed out of the physical, the process must be reversed. There can be no doubt that the external world is a construction of, and in, consciousness, but is its reality, for that reason, in any way dependent upon consciousness? It was shown that consciousness is entirely different in its nature from the physical. If the former is unreal, the physical, as a construction in it, also loses its reality. The integrity of consciousness in its own nature must be preserved, and apart from it we cannot hope to find reality.

On Propositions called Spurious, by B. I. Gilman.

At the last meeting Mr. Peirce developed, by means of the Algebra of Relatives, the syllogistic of the two fundamental propositions of common logic 'All *a* is *b*' and 'Some *a* is *b*'; in the notation of relatives $1 \prec \breve{\bar{a}} \dagger b$ and $1 \prec \breve{a}b$. Besides the propositional forms on which it was founded, this syllogistic gave two other conclusions of the forms $1 \prec \breve{\bar{a}} \dagger \mathrm{n}b$ and $1 \prec \breve{a}\mathrm{n}b$, in which n denotes the relative 'other than.'

An examination of the different possible values which the relative n*b* may assume, enables us to make the following analysis of the meaning of these propositions. The former is a universal, the latter a particular proposition. $1 \prec \breve{\bar{a}} \dagger \mathrm{n}b$ is always true when there is more than one *b*, while if there is but one *b* it is not *a*, and if *b* does not exist neither does *a*. $1 \prec \breve{a}\mathrm{n}b$ asserts the existence of both *a* and *b*, and if either is plural is always true, while if both are singulars they are different objects. The universal proposition may be expressed in words, Any given *a* is other than some *b*, or, more shortly, Any *a* is not some *b*. The particular may be expressed, Some determinate *a* is other than some determinate *b*, or, Some *a* is not some *b*. The latter form is the same as Hamilton's proposition *Ini*, called spurious by De Morgan; and the former is what Hamilton's proposition *Ani* becomes, if instead of interpreting 'any' collectively as he does, and reducing the proposition to *O* read backward, 'any' is given a distributive meaning. With this difference the two propositions are those of Hamilton's scheme, called η and ω by Thomson and rejected by him.

Regarding the relative n in combination with others as the mark of spurious propositions, they may exist in an indefinite succession of higher degrees in n. The proposition $1 \prec \breve{a}\mathrm{n} \dagger \mathrm{n}b$ is spurious in the second degree. It asserts that both terms exist, and that one is a singular, and that if the other is a singular the two are not the same object.

From two spurious propositions of the first order a genuine conclusion may be syllogistically drawn by the elimination of the relative n*b*. This may be effected by propositions of either of the following forms,

$$1 \prec \breve{\bar{b}} \dagger 1 \dagger c$$
$$1 \prec (\breve{\bar{b}} \dagger 1)\, c$$

for which the name anti-spurious was suggested by Mr. Peirce. The first of these propositions asserts as follows, viz: that if one term includes the whole universe the other does not; again, that if one term includes everything but one object, the other includes at least everything but one; while if one term includes less than everything but one object, the other includes everything. Further, if the two terms are singulars the universe consists of only these two different objects.

The latter, or particular anti-spurious proposition asserts that if there is no *b*, *c* must exist, while if there is but one it is *c*, and if there is more than one, *c* cannot exist.

Mathematical Society.

May meeting.

Note on the Formulæ of Trigonometry, by Professor A. Cayley.

The equations $a = c \cos B + b \cos C$, $b = a \cos C + c \cos A$, $c = b \cos A + a \cos B$, which connect together the sides a, b, c and the angles A, B, C of a plane triangle, may be presented in an algebraical rational form, by introducing in place of the angles a, b, c the functions $\cos A + i \sin A$, $\cos B + i \sin B$, $\cos C + i \sin C$, viz: calling these $\frac{x}{w}, \frac{y}{w}, \frac{z}{w}$ respectively, or what is the same thing, writing $2 \cos A = \frac{x}{w} + \frac{w}{x}$, $2 \cos B = \frac{y}{w} + \frac{w}{y}$, $2 \cos C = \frac{z}{w} + \frac{w}{z}$, then the foregoing equations may be written

$$\begin{aligned}
&\big(-2yzw,\quad y(z^2+w^2),\quad z(y^2+w^2)\big)\!\big(a, b, c\big) = 0\,, \\
&\big(x(z^2+w^2),\quad -2zxw,\quad z(x^2+w^2)\big)\!\big(\quad ''\quad\big) = 0\,, \\
&\big(x(y^2+w^2),\quad y(x^2+w^2),\quad -2xyw\big)\!\big(\quad ''\quad\big) = 0\,,
\end{aligned}$$

that is as a system of bipartite equations linear in (a, b, c) and cubic in (x, y, z, w) respectively.

Similarly in Spherical Trigonometry, writing as above for the angles, and for the sides writing in like manner $2 \cos a = \frac{a}{\delta} + \frac{\delta}{a}$, $2 \cos b = \frac{\beta}{\delta} + \frac{\delta}{\beta}$, $2 \cos c = \frac{\gamma}{\delta} + \frac{\delta}{\gamma}$, we have a system of bipartite equations separately homogeneous in regard to (x, y, x, w) and $(a, \beta, \gamma, \delta)$ respectively.

A Word on Nonions, by J. J. Sylvester.

In my lectures on Multiple Algebra I showed that if u, v are two matrices of the second order, and if the determinant of the matrix $(z + yv + xu)$ be written as $z^2 + 2bxz + 2cyz + dx^2 + 2exy + fy^2$ then the necessary and sufficient conditions for the equation $vw + uv = 0$ are the following, viz.:

$$b = 0, \qquad c = 0, \qquad e = 0.$$

If to these conditions we superadd $d = 1$, $f = 1$, and write $uv = w$, then $u^2 = -1$, $v^2 = -1$, $w^2 = -1$, $uv = -vu = w$, $vw = -wv = u$, $wu = -uw = v$; and $1, u, v, w$ form a quaternion system. The conditions above stated will be satisfied if Det. $(z + yv + xu) = z^2 + y^2 + x^2$, which will obviously be the case if $v = \begin{matrix} 0 & 1 \\ -1 & 0 \end{matrix}$, $u = \begin{matrix} 0 & \theta \\ \theta & 0 \end{matrix}$, where $\theta = \sqrt{-1}$. For then $z + yv + xu = \begin{vmatrix} z & y + x\theta \\ -y + x\theta & z \end{vmatrix}$. Hence the matrices

$$\begin{array}{cc|cc|cc|cc|} 1 & 0 & 0 & 1 & 0 & \theta & -\theta & 0 \\ 0 & 1 & -1 & 0 & \theta & 0 & 0 & \theta \end{array}$$

construed as complex quantities are a linear transformation of the ordinary quaternion system $1, i, j, k$; that is to say, if we form the multiplication table

	λ	μ	ν	τ
λ	λ	μ	0	0
μ	0	0	λ	μ
ν	ν	τ	0	0
τ	0	0	ν	τ

$$\begin{aligned} \lambda + \tau &= 1 & -\mu + \nu &= i \\ -\theta\lambda + \theta\tau &= k & \theta\mu + \theta\nu &= j\,. \end{aligned}$$

Since u, v contain between them 8 letters subject to the satisfaction of 5 conditions, the most general values of λ, μ, ν, τ ought to contain 8 arbitrary constants; but it is well known that any particular (i, j, k) system may be superseded by a $\lambda\,(i', j', k')$ system, where i', j', k' are orthogonally related linear functions of i, j, k; and as this substitution introduces just 8 arbitrary constants, we may, by aid of it, pass from the system of matrices above given, to the most general form. The general expression for the matrices containing 8 arbitrary constants may also be found directly by the method given in my lectures, which will be reproduced in the memoir on Multiple Algebra in the *Mathematical Journal.* What goes before is by way of introduction to the *word* on Nonions which follows.

Just as the necessary and sufficient condition that u, v, two matrices of the second order, may satisfy the equations $vu = -uv$, $u^2 = 1$, $v^2 = 1$, is that the determinant to $z + yv + xu$ may be $z^2 + y^2 + x^2$, so I have proved that the necessary and sufficient condition, in order that we may have $vu = \rho uv$, $u^3 = 1$, $v^3 = 1$, (u, v being matrices of the third order, and ρ an imaginary cube root of unity) is that the determinant to $z + yv + xu$ may be $z^3 + y^3 + x^3$; but if we make

$$u = \begin{matrix} 0 & 0 & 1 \\ \rho & 0 & 0 \\ 0 & \rho^2 & 0 \end{matrix}, \quad v = \begin{matrix} 0 & 0 & 1 \\ \rho^2 & 0 & 0 \\ 0 & \rho & 0 \end{matrix}, \text{ then}$$

$$z + yv + xu = \begin{vmatrix} z & 0 & y + x \\ \rho y + \rho^2 x & z & 0 \\ 0 & \rho^2 y + \rho x & z \end{vmatrix}$$

of which the determinant is

$$\zeta z^3 + (y + x)(\rho\gamma + \rho^2 x)(\rho^2 y + \rho x) = z^3 + y^3 + x^3 .$$

Hence there will be a system of Nonions (precisely analogous to the known system of quaternions) represented by the 9 matrices

$$\begin{array}{ccccc} & & 1 & & \\ & u & & v & \\ u^2 & & uv & & v^2 \\ & u^2 v & & uv^2 & \\ & & u^2 v^2 & & \end{array}$$

and just as in the preceding case the 8 terms ± 1, $\pm u$, $\pm v$, $\pm uv$ form a closed group, so here the 27 terms obtained by multiplying each of the above 9 by 1, ρ, ρ^2 will form a closed group. The values of the 9 matrices will easily be found to be

$$\begin{array}{ccccc} & & \begin{matrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{matrix} & & \\ & \begin{matrix} 0 & 0 & 1 \\ \rho & 0 & 0 \\ 0 & \rho^2 & 0 \end{matrix} & & \begin{matrix} 0 & 0 & 1 \\ \rho^2 & 0 & 0 \\ 0 & \rho & 0 \end{matrix} & \\ \begin{matrix} 0 & \rho^2 & 0 \\ 0 & 0 & \rho \\ 1 & 0 & 0 \end{matrix} & & \begin{matrix} 0 & \rho^2 & 0 \\ 0 & 0 & \rho^2 \\ \rho^2 & 0 & 0 \end{matrix} & & \begin{matrix} 0 & \rho & 0 \\ 0 & 0 & \rho^2 \\ 1 & 0 & 0 \end{matrix} \\ & \begin{matrix} 1 & 0 & 0 \\ 0 & \rho & 0 \\ 0 & 0 & \rho^2 \end{matrix} & & \begin{matrix} \rho^2 & 0 & 0 \\ 0 & \rho & 0 \\ 0 & 0 & 1 \end{matrix} & \\ & & \begin{matrix} 0 & 0 & \rho^2 \\ \rho^2 & 0 & 0 \\ 0 & \rho^2 & 0 \end{matrix} & & \end{array}$$

These forms can be derived from an algebra given by Mr. Charles S. Peirce, (*Logic of Relatives*, 1870.)

I will only stay to observe that as the condition of the Determinant to $z + uy + vx$ (which for general values of u, v is a general cubic with the coefficient of z^3 unity) assuming the form $z^3 + y^3 + x^3$, implies the satisfaction of 9 conditions, and as u, v between them contain 18 constants, the most general form of a system of Nonions must contain 18 — 9, or 9 arbitrary constants; but how these can be obtained from the particular form of the system above given, remains open for further examination.

On Cubics and Systems of Conics, by F. Franklin.

In this communication some additional points connected with the investigation presented at the April meeting, were brought forward. These will also be embodied in an article shortly to appear in the *American Journal of Mathematics.*

Note on Binodal Quartics, by E. W. Davis.

The equation of the binodal quartic can always be put in the form

$$(1) \qquad x^2 y^2 + z^2(ax^2 + by^2 + cz^2 + 2fyz + 2gzx + 2hxy) = 0 .$$

$$\therefore \left(\frac{x^2}{z^2} + b\right)\frac{y}{2} = -f - h\frac{x}{z}$$
$$\pm\sqrt{-a\frac{x^4}{z^4} - 2g\frac{x^3}{z^3} - (c + ab - h^2)\frac{x^2}{z^2} - 2(bg - hf)\frac{x}{z} - (bc - f^2)}$$
$$= -f - h\frac{x}{z} \pm \sqrt{-a\left(\frac{x}{z} - a\right)\left(\frac{x}{z} - \beta\right)\left(\frac{x}{z} - \gamma\right)\left(\frac{x}{z} - \delta\right)}$$

where we assume $a < \beta < \gamma < \delta$.

If we write

$$\frac{x}{z} = \frac{a(\beta - \delta) + \delta(a - \beta)\,\mathrm{sn}^2 u}{\beta - \delta + (a - \beta)\,\mathrm{sn}^2 u} = \frac{M}{N} \text{ say,}$$

u being a variable parameter, and $\dfrac{(a - \beta)(\gamma - \delta)}{(a - \gamma)(\beta - \delta)} = k^2$, we get

$$x : y : z = M(M^2 + bN^2) : -N(fN^2 + hMN \pm n\,\mathrm{sn}u\,\mathrm{cn}u\,\mathrm{dn}u) : N(M^2 + bN^2).$$

Here n is a new constant.

The condition that the points 1 and 2 should be co-linear with (xz) is

$$u_1 + u_2 \equiv 0 \text{ mod. half period.}$$

For the tangents from (xz) to the curve

$$\begin{array}{lllll} \dfrac{x}{z} = & a, & \beta, & \gamma, & \delta; \\ u_1 = u_2 = u \equiv 0, & K, & K + iK', & iK' & \text{mod. half period.} \end{array}$$

Between $x = az$ and $x = \beta z$, $u \equiv K \pm \lambda$ mod. half period $(K > \lambda > 0)$
" $x = \beta z$ " $x = \gamma z$, $u \equiv K \pm i\lambda$ " " " $(0 < \lambda < K')$
" $x = \gamma z$ " $x = \delta z$, $u \equiv X + iK' \pm i\gamma$ " " " $(K > \lambda > 0)$
" $x = \delta z$ " $x = az$, $u \equiv \pm i\lambda$ " " " $(K' > \lambda > 0)$

Had we solved (1) for $\dfrac{x}{z}$ and put $\dfrac{y}{z} = \dfrac{a'(\beta' - \delta') + \delta'(a' - \beta')\,\mathrm{sn}^2 v}{\beta' - \delta' + (a' - \beta')\,\mathrm{sn}^2 v}$, k^2 being the same, since $\dfrac{(a - \beta)(\gamma - \delta)}{(a - \gamma)(\beta - \delta)} = \dfrac{(a' - \beta')(\gamma' - \delta')}{(a' - \gamma')(\beta' - \delta')}$, we should have obtained results for the node (yz) identical with those for the node (xz) *mutatis mutandis.*

If $\quad u_1 + u_2 \equiv 0$ mod. half period
and $\quad v_3 + v_4 \equiv 0$ " " " while $u_1 \equiv v_3$ mod. half period,
then the line $\overline{12}$ through (xz) meets the line $\overline{34}$ through (yz) on a conic which passes through the nodes and through the intersections of corresponding tangents to the curve from the nodes.

Note on Determinants of Powers, by O. H. Mitchell.

If $a > \beta > \gamma$, and $\zeta^{\frac{1}{2}}(x, y, z) = (x - y)(x - z)(y - z)$, then

$$\begin{vmatrix} a^a a^\beta a^\gamma \\ b^a b^\beta b^\gamma \\ c^a c^\beta c^\gamma \end{vmatrix} \div \begin{vmatrix} a^2 a^1 a^0 \\ b^2 b^1 b^0 \\ c^2 c^1 c^0 \end{vmatrix} = \frac{\zeta^{\frac{1}{2}}(a, \beta, \gamma)}{\zeta^{\frac{1}{2}}(2, 1, 0)}$$

terms, all *positive*, and the like is true for determinants of any order. The value of the above quotient (see Salmon's Higher Algebra, p. 292) is

$$\begin{vmatrix} H_{a-2} & H_{\beta-2} & H_{\gamma-2} \\ H_{a-1} & H_{\beta-1} & H_{\gamma-1} \\ H_a & H_\beta & H_\gamma \end{vmatrix},$$

where H_m denotes the sum of all possible powers and products of the mth degree of a, b, c. We have, for determinants of the fourth order,

$$\frac{(a^a b^\beta c^\gamma d^\delta)}{(a^3 b^2 c^1 d^0)} = (H_{a-3} H_{\beta-2} H_{\gamma-1} H_\delta)$$
$$= a^\delta b^\delta c^\delta d^\delta (H_{a-\delta-3} H_{\beta-\delta-2} H_{\gamma-\delta-1}),$$

since $H_0 = 1$ and $H_{-m} = 0$. Expanding each element of the last determinant by means of the formula,

$$H_m(a, b, c, d) = d^m + d^{m-1}H_1(a, b, c) + d^{m-2}H_2(a, b, c) + \text{etc.},$$

we get, after reduction,

$$\frac{(a^a b^\beta c^\gamma d^\delta)}{(a^3 b^2 c^1 d^0)} = a^\delta b^\delta c^\delta d^\delta \sum_{x=\beta-\delta}^{x=a-\delta-1} \; \sum_{y=\gamma-\delta}^{y=\beta-\delta-1} \; \sum_{z=0}^{z=\gamma-\delta-1} d^\theta \frac{(a^x b^y c^z)}{(a^2 b^1 c^0)},$$

where $\theta = a + \beta + \gamma + \delta - 8 - 4\delta - (x + y + z)$. Calling the left hand member Q_4, we see that Q_4 is expressed as a linear function with positive coefficients of Q_3. In the same way Q_n may be expressed in terms of Q_{n-1}. Hence if Q_{n-1} consist of positive terms only, the same will be true of Q_n. But $Q_2 = \dfrac{(a^a b^\beta)}{(a^1 b^0)} = b^\beta H_{a-\beta-1}$, which consists of positive terms exclusively. Therefore etc.

The number of terms in the H_m of n letters is expressed by the binomial coefficient C_{n-1}^{m+n-1}. Hence the number of terms in Q_3, $= (H_{a-2} H_{\beta-1} H_\gamma)$, is

$$\left(C_2^a C_2^{\beta+1} C_2^{\gamma+2}\right), = \left(C_2^a C_1^\beta C_0^\gamma\right), = \frac{\zeta^{\frac{1}{2}}(a, \beta, \gamma)}{\zeta^{\frac{1}{2}}(2, 1, 0)};$$

and the like is true for Q_n.

It may be remarked that if the last row of Δ, $= (a^a b^\beta c^\gamma)$, be subtracted from each of the preceding rows, and these rows be then divided by $(a - c)$, $(b - c)$, and the second row be then subtracted from the first and the result divided by $(a - b)$, we get

$$\frac{(a^a b^\beta c^\gamma)}{(a^2 b^1 c^0)} = \begin{vmatrix} H_{a-2}(a, b, c), & H_{\beta-2}(a, b, c), & H_{\gamma-2}(a, b, c) \\ H_{a-1}(b, c) \quad , & H_{\beta-1}(b, c) \quad , & H_{\gamma-1}(b, c) \\ H_a(c) \quad , & H_\beta(c) \quad , & H_\gamma(c) \end{vmatrix}.$$

And since $bH_{a-1}(b, c) + H_a(c) = H_a(b, c)$, and $aH_{a-2}(a, b, c) + H_{a-1}(b, c) = H_{a-1}(a, b, c)$, etc, the determinant on the right is at once reduced by combination of rows to the similar determinant, already considered, where each row involves every letter. And the like is true for determinants of any order.

On Mechanical Involution, by J. J. Sylvester.

Many years ago I gave in the *Comptes Rendus* of the Institute of France, one or more geometrical constructions of the problem of Mechanical Involution.

When forces can be introduced along six given lines in space whose statical sum is zero, a certain geometrical condition must be fulfilled by the 6 lines which are then said to be in involution. If two homographic pencils of rays in different planes have two corresponding rays coincident, (but their centres apart), any six lines, each of which cuts two corresponding rays, will form an involution system. In the communication to the Society I showed that the analytical condition of involution might be expressed by means of equating to zero a certain compound determinant. I have found since that this determinant is given by Cayley in the Cam. Phil. Soc. Tr. 1861, pt. 2.

Let 1, 2, 3, 4, 5, 6 be the six lines and on each of them let two arbitrary points be taken; let the quadri-planar coordinates of the two arbitrary points on any of the lines, say j, be called j_x, j_y, j_z, j_t; j'_x, j'_y, j'_z, j'_t, respectively, the condition of involution referred to will be

$$\begin{vmatrix} & 1.2 & 1.3 & 1.4 & 1.5 & 1.6 \\ 2.1 & & 2.3 & 2\,4 & 2.5 & 2.6 \\ 3.1 & 3.2 & & 3.4 & 3.5 & 3.6 \\ 4.1 & 4\,2 & 4.3 & & 4.5 & 4\,6 \\ 5.1 & 5.2 & 5.3 & 5.4 & & 5.6 \\ 6.1 & 6\,2 & 6.3 & 6\,4 & 6.5 & \end{vmatrix} = 0$$

where any binary combination $ij = ji$, and where either of them represents the determinant

$$\begin{matrix} i_x, & i_y, & i_z, & i_t \\ i'_x, & i'_y, & i'_z, & i'_t \\ j_x, & j_y, & j_z, & j_t \\ j'_x, & j'_y, & j'_z, & j'_t \end{matrix}$$

Six lines in involution represent indifferently lines along which forces or axes of couples can be introduced, whose statical sum is zero. Consequently such a system is the analogue in space at one and the same time to three force-lines converging to a point, or to three points in a line regarded as centres of moments, in a plane. But *in plano* the concurrence of right lines is the polar property to the collineation of points. Hence we ought to expect that the polar reciprocal in respect to any quadric of an involution system, should also be an involution system; and such is obviously the case by virtue of the fact that the correspondence of the rays in the two homographic pencils, referred to at line 7 above, will not be affected when for each ray in either pencil is substituted its polar in respect to any quadric. (A direct proof will be found in the *American Mathematical Journal*, Vol. IV, part 4, shortly to appear.) I concluded with pointing out the analogy between the problem of Mechanical Involution and what I call Algebraical Involution, which takes place when x, y being each of them matrices of the order ω, a linear equation connects the ω^2 ground forms represented by the distinct terms of the product

$$\left(1, x, x^2, \ldots x^{\omega-1}\right)\!\!\left(1, y, y^2, \ldots y^{\omega-1}\right)$$

Mechanical involution in a plane, in 3-dimensional, in 4-dimensional space, etc., is the analogue of algebraical involution between two matrices of the order 2, 3, 4, etc.; the $\frac{\omega^2+\omega}{2}$ directions in ω-dimensional space being the analogues of the ω^2 ground-forms of matrices of the order ω. Each of the two problems consists of two parts: to obtain the condition of involution being the one part, to assign the relative magnitudes, in the one case, of the forces which cause their statical sum to vanish, and in the other case of the coefficients which enter into the linear function, the other part of the problem. The form of the solution of this second part of the algebraical problem (subject only to a certain ambiguity) has been given in my lectures, and will appear in the Memoir on Multiple Algebra in the *American Journal of Mathematics*; but the former part of the algebraical problem, *i. e.*, the determination of the *condition* of Algebraical Involution, except for the case of matrices of the second order, I have not yet succeeded in solving.

SYNOPSIS OF THE RECENT SCIENTIFIC JOURNALS

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Article I.—Nonius Marcellus. I. By Henry Nettleship.

The name of Nonius Marcellus is associated with dulness and ignorance, and yet his work *De Compendiosa Doctrina* is so important that no student of Latin can afford to ignore it. Nonius belonged to Thubursicūm in Africa, and has been identified by Mommsen with the Nonius of a Thubursican inscription of the year 328 A. D. Very few of his quotations come from any author later than the Augustan age. This remarkable fact is to be explained by a curious reaction in favor of the past, which is a notable phenomenon in the history of the later Latin literature. This reaction set in during the latter half of the second century, of which we have a suggestive record in the *Dialogus de Oratoribus* of Tacitus, written about 80 A. D. Tacitus at that time belonged to the party of the *antiquarii*, and the same literary tradition was continued by Quintilian. To this influence we must add the growth of the science of grammar and criticism, for by the end of the first century A. D. the critical study of the ancient authors had fairly begun. Probus is a prominent instance. To the time of Trajan belong the grammarians Flavius Caper and Velius Longus, and to the same period the *Stromateus* of Caesellius Vindex. To such authors and their predecessors Aulus Gellius, who flourished from 120–170 A. D., owes the material of his *Noctes Atticae.* The taste of Gellius is the taste of the antiquarian; he cites from some of his contemporaries, but, with this exception, Vergil and Horace are the latest authors which he quotes. A far abler and more genuinely learned man was Lucius Apuleius of Madaura in Numidia, a contemporary of Gellius and a very striking representative of his age. His style shows that he spent much *aerumnabilis labor* in mastering Roman antiquities and literature, and he has preserved for us in a living connexion many words which would otherwise have remained mere dictionary vocables. His manner is not peculiarly African; his studies were carried on at Rome, and his language is based on antiquarian study, although there is undoubtedly also a considerable part which represents the living popular Latin current in Africa at his time. Tertullian, a generation younger than Apuleius with all his rhetorical training and bias, is almost a popular writer as compared with Apuleius, and shows us the difference between the Pagan scholar and philosopher, and the Christian advocate. The social and moral conflict between Christianity and Paganism extended into the world of antiquarianism and of study. The Pagans continued to collect the relics of the flourishing past, the Christians went on to destroy the Pagan religion with the weapons offered by Pagan philosophy.—See Minucius Felix, Tertullian, and Arnobius, the last of whom seems to have given special attention to the classical literature of Italy. Of this Arnobius our Nonius must have been a contemporary, as he was a countryman. In his school encyclopaedia called *De Compendiosa Doctrina*, Nonius ignores Christianity persistently, styles himself a Peripatetic, and justifies us in classing him as a product of the reactionary Roman feeling which meets us again in Macrobius. After this general introduction Professor Nettleship gives the titles of the twenty books of Nonius with some account of his romances, reserving a detailed examination of the first book of Nonius for the next number.

Article II.—On the Separation, by a Word or Words, of TO *in the Infinitive Mood.* By Fitzedward Hall.

Our infinitive with *to* was of old dativo-gerundial, so that "able *to thoroughly bake* bread" stands in connexion with "conducive *to thoroughly baking* bread." In the discussion of this separation of *to* from the infinitive mood, Dr. Hall criticises the dogmatism of certain writers on English, such as Mr. Richard Taylor and Dean Alford, and shows that so far as the age of the separation is concerned, it has the warrant of Wycliff's coadjutors and first disciples. Bishop Pecock's *Repressor* (about 1456) is thickly strewn with expressions like *forto first geve*, and while Dr. Hall has nothing in point to produce for the next fifty years, he has presented the reader with a *catena* of examples covering the period from Lord Berners (1523–1525) to Mr. Leslie Stephen and Mr. Mallock. Dr. Hall sees in this usage a legitimate extension of the principle which has given us *backslide, foretell*, and the like, and we are under no necessity of setting to the account of "affectation" the choice of locutions like *to fully appreciate.* Closer "notional incomplexity" and greater clearness are sufficient justifications in Dr. Hall's judgment, although he does not fail to notice that Dr. Johnson, Lord Macaulay, and Mr. De Quincey, all voluminous authors, furnish only one example each and thus just countenanced this type.

Article III.—Final AS *before Sonants in. Sanskrit.* By Maurice Bloomfield.

"The main purpose of this paper is the explanation of the change of final *as* into *ō*. The *ō* before sonant consonants is not a diphthong; it is long *ō*, the result of short *ŏ* plus the voice of the sonant sibilant, which has fallen out, but has left its traces in the lengthening of the preceding short vowel. Short Indo-European *ŏ* is then not entirely dead upon Indian ground any more than short I. E. *ĕ;* both have escaped into certain long *ē* and *ō*; the euphonic change in a complex *açvō dravati* differs from that of a complex *ē dhí* only in the quality of the short vowel which has preceded the change; * *açvŏz dravati* is the immediate historic precursor of *açvō dravati* precisely as *ĕz dhi* is of *ē-dhí.*"

Article IV.—The Change of TH *into* T *in the Orrmulum.* By F. A. Blackburn.

Mr. Blackburn's study of the Orrmulum has led him to the following conclusion: "1. That in the twelfth and thirteenth centuries the two sounds of initial *th* were already in existence as they now are, and in the same words. 2. That monosyllabic words of pronominal derivation were subject to a weakening and assimilation of the initial *th* sound to *t* after *d* and *t*, less often after *s*; the result of a kind of inclination and consequent loss of accent. 8. That the extension of this change to all pronominal words in the Orrmulum is artificial and the result of the author's desire for regularity; a desire shown also in his grammar, spelling and metre."

Article V.—On Bentley's English MSS. of Terence. By Minton Warren.

Although scarce a decade has passed since the appearance of Umpfenbach's edition of Terence, the need of more exhaustive work, with more complete and accurate collations and a sharper discrimination between the three families of Terence MSS., has already made itself felt. So the collation of the Parisinus, the leading representative of the pure Calliopian recension, is unsatisfactory to the writer of this paper, and to substantiate his strictures Dr. Warren cites his own readings in some passages of the Andria. After this general statement of the necessity of more careful collations, Dr. Warren considers the MSS used by Bentley, and endeavors to determine definitely what were the *Codices Regii* used by that illustrious critic. 8 D XVII is a fragment, the orthography is poor, the text corrupt, and there is no evidence of Bentley's having consulted this MS. On the other hand, he does quote from each of the four remaining *Regii*. *Regius* 15 A VIII has been followed by Bentley in nine out of twelve passages, in which it is referred to, but in no case has his reading been accepted by recent editors and in four of the most important passages Bentley changed his mind. 15 B VIII is quoted by Bentley in twenty-two passages; in fifteen Bentley based his own reading upon this MS., in six of which, however, he withdrew his own emendation. On the readings of *Regius* 15 A XI Bentley seems to have set a high value. *Regius* 15 A XII, which is assigned by the catalogue to the tenth century, is the one most frequently cited by Bentley, and a careful collation of this MS. shows many points of agreement with DG. After thus identifying by actual examination the *Codices Regii* used by Bentley, Dr. Warren consulted the copy of Terence in which Bentley recorded his MS. collations. One of the oldest MSS. M (*Cod. Jo. Mori Episc. Eliensis*) has not yet been identified, but as the *Dunelmensis*, called by Bentley *veterrimus*, has been brought to light, there is room for hope that M will also be forthcoming. The article closes with some specimens of Bentley's MS. readings.

Article VI.—"For—Sake." By James M. Garnett.

This locution does not occur in the A. S. Gospels nor in Wycliffe's New Testament, but first came in with Tyndale. Dr. J. A. H. Murray has not been able to carry *for -s sake* back beyond the Ancren Riwle (c. 1220–80.) Dr. Garnett has added to Dr. Murray's four examples twenty-six of *sake* in this special sense, in the thirteenth and fourteenth centuries. The expression *for the sake of* is of later origin and partly arose in the North. It is not found in the Authorized Version, but the Revisers have occasionally made use of it.

The *Reviews* and *Book Notices* treat of *Recent work in Old Norse*, (W. H. Carpenter); *MacMahon's Brédif's Demosthenes*, (M. L. D'Ooge); Deffner's *Zakonische Grammatik*, (T. D. S.); Ellis's *Ibis*, (B. L. G.); Hayman's *Odyssey*, (L. R. P.); *Anecdota Oxoniensia* and *Transactions of Cambridge Philological Society*, (B. L. G.); Kölbing's *Elis Saga ok Rosamundu*, (W. H. Carpenter); Campbell's *Sophocles*, (J. W. W.)

Reports are given of *Anglia*, *Hermes*, *Mnemosyne*, *Revue de Philologie*, *Romania*.

In the *Correspondence* are found letters from L R. Packard, *on* A H. Sayce's *Language of Homer*; from A. D. Savage, *on the Dipylon Vases*; from Lewis Campbell and Robinson Ellis, *on the Fragments of Sophocles*.

Contents of No. 10 (now in press). Continuation of Professor Charles Short's article on the *New Revision of the Authorized Version* (see No. 6); a conclusion of Professor Nettleship's article on *Nonius Marcellus*; an *unpublished Greek inscription* edited by Professor F. D. Allen—*Notes* on *Jefferson as a Philologian* by Professor H. E. Shepherd; on a passage *in Demosthenes* by Professor C. D. Morris; on *Malum* by Professor E. Morris; on the *Articular Infinitive* by the Editor; besides *Reports, Correspondence, Recent Publications.*

American Chemical Journal. Edited by Professor Remsen. Contents of *Vol. IV, No.* 3.

Article I.—On the Sulpho-cinnamic Acids. By Chase Palmer.

Article II.—On Substituted Acrylic and Propionic Acids. By Henry B. Hill.

Article III.—On the Determination of so-called Reverted Phosphoric Acid. By Clifford Richardson.

Article IV.—On some Derivatives of Oxytoluic Acid. By R. W. Mahon.

Article V.—Note on the Ammonia Process for Water Analysis. By Charles W. Marsh.

Article VI.—On the Benzoyl Derivatives of the Xylenesulphamides. By R. W. Mahon.

Article VII.—Protection of a Group containing Two Carbon Atoms. By Ira Remsen and W. A. Noyes.

Article VIII.—On a New Fat Acid. By J. M. Stillman and E. O'Neill.

Article IX.—On the Precipitation of Titanic Acid. By P. T. Austen and F. A. Wilber.

Report on Agricultural Chemistry. By H. P. Armsby.

Report on Physiological Chemistry. By R. H. Chittenden.

The Manufacture of Steel and Ingot Iron from Phosphoric Iron Ore.

Notes.

American Journal of Mathematics. Edited by Professor Sylvester. Contents of *Vol. IV., No.* 4.

Article I.—Forms of Rolle's Theorem (Concluded). By J. C. Glashan.

Article II.—On the 8-square Imaginaries. By Arthur Cayley.

Article III.—On certain Metrical Properties of Surfaces. By Thomas Craig.

Article IV.—Note on the Theory of Simultaneous Linear Differential or Difference Equations with Constant Coefficients. By J. J. Sylvester.

Article V.—Alhazen's Problem. By Marcus Baker.

Article VI.—On the non-Euclidean Trigonometry. By W. E. Story.

Article VII.—Note on Mechanical Involution. By J. J. Sylvester.

Article VIII.—Note on Determinants of Powers. By O. H. Mitchell.

Article IX.—Determination of the Finite Quaternion Groups. By W. I. Stringham.

Article X.—On the Counter-Pedal Surface of the Ellipsoid. By Thomas Craig.

Article XI.—Tables for the Binary Sextic. By Arthur Cayley.

RESULTS ACCOMPLISHED IN THE MANUFACTURE AND THEORY OF GRATINGS FOR OPTICAL PURPOSES, A PRELIMINARY NOTICE.

By H. A. ROWLAND.

It is not many years since physicists considered that a spectroscope constructed of a large number of prisms was the best and only instrument for viewing the spectrum, where great power was required. These instruments were large and expensive, so that few physicists could possess them. Professor Young was the first to discover that some of the gratings of Mr. Rutherfurd showed more than any prism spectroscope which had then been constructed. But all the gratings which had been made up to that time were quite small, say one inch square, whereas the power of a grating in resolving the lines of the spectrum increases with the size. Mr. Rutherfurd then attempted to make as large gratings as his machine would allow, and produced some which were nearly two inches square, though he was rarely successful above an inch and three-quarters, having about thirty thousand lines. These gratings were on speculum metal and showed more of the spectrum than had ever before been seen, and have, in the hands of Young, Rutherfurd, Lockyer and others, done much good work for science. Many mechanics in this country and in France and Germany, have sought to equal Mr. Rutherfurd's gratings, but without success.

Under these circumstances, I have taken up the subject with the resources at command in the physical laboratory of the Johns Hopkins University.

One of the problems to be solved in making a machine is to make a perfect screw, and this, mechanics of all countries have sought to do for over a hundred years and have failed. On thinking over the matter, I devised a plan whose details I shall soon publish, by which I hoped to make a practically perfect screw, and so important did the problem seem that I immediately set Mr. Schneider, the instrument maker of the university, at work at one. The operation seemed so successful that I immediately designed the remainder of the machine, and have now had the pleasure since Christmas of trying it. The screw is practically perfect, not by accident, but because of the new process for making it, and I have not yet been able to detect an error so great as one one-hundred-thousandth part of an inch at any part. Neither has it any appreciable periodic error. By means of this machine I have been able to make gratings with 43,000 lines to the inch, and have made a ruled surface with 160,000 lines on it, having about 29,000 lines to the inch. The capacity of the machine is to rule a surface 6¼ x 4¼ inches with any required number of lines to the inch, the number only being limited by the wear of the diamond. The machine can be set to almost any number of lines to the inch, but I have not hitherto attempted more than 43,000 lines to the inch. It ruled so perfectly at this figure that I see no reason to doubt that at least two or three times that number might be ruled in one inch, though it would be useless for making gratings.

All gratings hitherto made have been ruled on flat surfaces. Such gratings require a pair of telescopes for viewing the spectrum; these telescopes interfere with many experiments, absorbing the extremities of the spectrum strongly; besides, two telescopes of sufficient size to use with six inch gratings would be very expensive and clumsy affairs. In thinking over what would happen were the grating ruled on a surface not flat, I thought of a new method of attacking the problem, and soon found that if the lines were ruled on a spherical surface the spectrum would be brought to a focus without any telescope. This discovery of concave gratings is important for many physical investigations, such as the photographing of the spectrum both in the ultra-violet and the ultra-red, the determination of the heating effect of the different rays, and the determination of the relative wave lengths of the lines of the spectrum. Furthermore it reduces the spectroscope to its simplest proportions, so that spectroscopes of the highest power may be made at a cost which can place them in the hands of all observers. With one of my new concave gratings I have been able to detect double lines in the spectrum which were never before seen.

The laws of the concave grating are very beautiful on account of their simplicity, especially in the case where it will be used most. Draw the radius of curvature of the mirror to the center of the mirror, and from its central point with a radius equal to half the radius of curvature draw a circle; this circle thus passes through the center of curvature of the mirror and touches the mirror at its center. Now if the source of light is anywhere in this circle, the image of this source and the different orders of the spectra are all brought to focus on this circle. The word focus is hardly applicable to the case, however, for if the source of light is a point the light is not brought to a single point on the circle but is drawn out into a straight line with its length parallel to the axis of the circle. As the object is to see lines in the spectrum only, this fact is of little consequence provided the slit which is the source of light is parallel to the axis of the circle. Indeed it adds to the beauty of the spectra, as the horizontal lines due to dust in the slit are never present, as the dust has a different focal length from the lines of the spectrum. This action of the concave grating, however, somewhat impairs the light, especially of the higher orders, but the introduction of a cylindrical lens greatly obviates this inconvenience.

The beautiful simplicity of the fact that the line of foci of the different orders of the spectra are on the circle described above leads immediately to a mechanical contrivance by which we can move from one spectrum to the next and yet have the apparatus always in focus; for we only have to attach the slit, the eye-piece and the grating to three arms of equal length, which are pivoted together at their other ends and the conditions are satisfied. However we move the three arms the spectra are always in focus. The most interesting case of this contrivance is when the bars carrying the eye-piece and grating are attached end to end thus forming a diameter of the circle with the eye-piece at the centre of curvature of the mirror, and the rod carrying the slit alone movable. In this case the spectrum as viewed by the eye-piece is normal, and when a micrometer is used the value of a division of its head in wave lengths does not depend on the position of the slit, but is simply proportional to the order of the spectrum, so that it need be determined once only. Furthermore, if the eye-piece is replaced by a photographic camera the photographic spectrum is a normal one. The mechanical means of keeping the focus is especially important when investigating the ultra-violet and ultra-red portions of the solar spectrum.

Another important property of the concave grating is that all the superimposed spectra are in exactly the same focus. When viewing such superimposed spectra it is a most beautiful sight to see the lines appear colored on a nearly white ground. By micrometric measurement of such superimposed spectra we have a most beautiful method of determining the relative wave lengths of the different portions of the spectrum, which far exceeds in accuracy any other method yet devised. In working in the ultra-violet or ultra-red portions of the spectrum we can also focus on the superimposed spectrum and so get the focus for the portion experimented on.

The fact that the light has to pass through no glass in the concave grating makes it important in the examination of the extremities of the spectrum where the glass might absorb very much.

There is one important research in which the concave grating in its present form does not seem to be of much use, and that is in the examination of the solar protuberances; an instrument can only be used for this purpose in which the dust in the slit and the lines of the spectrum are in focus at once. It might be possible to introduce a cylindrical lens in such a way as to obviate this difficulty. But for other work on the sun the concave grating will be found very useful. But its principal use will be to get the relative wave lengths of the lines of the spectrum, and so to map the spectrum; to divide lines of the spectrum which are very near together, and so to see as much as possible of the spectrum; to photograph the spectrum so that it shall be normal; to investigate the portions of the spectrum beyond the range of vision; and lastly to put in the hands of any physicist at a moderate cost such a powerful instrument as could only hitherto be purchased by wealthy individuals or institutions.

To give further information of what can be done in the way of gratings I will state the following particulars:

The dividing engine can rule a space 6¼ inches long and 4¼ inches wide. The lines, which can be 4¼ inches long, do not depart from a straight line so much as $\frac{1}{1000000}$ inch, and the carriage moves forward in an equally straight line. The screw is practically perfect and has been tested to $\frac{1}{1000000}$ inch without showing error. Neither does it have any appreciable periodic error, and the periodic error due to the mounting and graduated head can be entirely eliminated by a suitable attachment. For showing the production of ghosts by a periodic error, such an error can be introduced to any reasonable amount. Every grating made by the machine is a good one, dividing the 1,474 line with ease, but some are better than others. Rutherford's machine only made one in every four good, and only one in a long time which might be called first-class. One division of the head of the screw makes 14,438 lines to the inch. Any fraction of this number in which the numerator is not greater than say 20 or 30 can be ruled. Some exact numbers to the millimetre, such as 400, 800, 1200, etc., can also be ruled. For the finest definition either 14,438 or 28,876 lines to the inch are recommended, the first for ordinary use and the second for examining the extremities of the spectrum. Extremely brilliant gratings have been made with 43,314 lines to the inch, and there is little difficulty in ruling more if desired. The following show some results obtained:

Flat grating, 1 inch square, 43,000 lines to the inch. Divides the 1,474 line in the first spectrum.

Flat grating, 2 × 3 inches, 14,438 lines to the inch, total 43,314. Divides 1,474 in the first spectrum, the *E* line (Ångström 5,269.4) in the second and is good in the fourth and even fifth spectrum.

Flat grating, 2 × 3 inches, 1,200 lines to one millimetre. Shows very many more lines in the *B* and *A* groups than were ever before seen.

Flat grating, 2 × 3½ inches, 14,438 lines to the inch. This has most wonderful brilliancy in one of the first spectra, so that I have seen the *Z* line, wave length 8,240, (see Abney's map of the ultra-red region), and determined its wave length roughly, and have seen much further below the *A* line than the *B* line is above the *A* line. The same may be said of the violet end of the spectrum. But such gratings are only obtained by accident.

Concave grating, 2 × 3 inches, 7 feet radius of curvature, 4,818 lines to the inch. The coincidences of the spectra can be observed to the tenth or twelfth spectrum.

Concave grating, 2 × 3 inches, 14,438 lines to the inch, radius of curvature 8 feet. Divides the 1,474 line in the first spectrum, the *E* line in the second, and is good in the third or fourth.

Concave grating, 3 × 5½ inches, 17 feet radius of curvature, 28,876 lines to the inch, and thus nearly 160,000 lines in all. This shows more in the first spectrum than was ever seen before. Divides 1,474 and *E* very widely and shows the stronger component of Ångström 5,275 double. Second spectrum not tried.

Concave grating, 4 × 5¾ inches, 3,610 lines to the inch, radius of curvature 5 feet 4 inches. This grating was made for Professor Langley's experiments on the ultra-red portion of the spectrum, and was thus made very bright in the first spectrum. The definition seems to be very fine notwithstanding the short focus and divides the 1,474 line with ease. But it is difficult to rule so concave a grating as the diamond marks differently on the different parts of the plate.

These give illustrations of the results accomplished, but of course many other experiments have been made. I have not yet been able to decide whether the definition of the concave grating fully comes up to that of a flat grating, but it evidently does so very nearly.

Baltimore, May 25, 1882.

BRIEF NOTICES.

LETTER OF CHARLES DARWIN.—ANIMAL MIMICKRY.

The death of Charles Darwin has awakened so much interest in his personal character, as well as in his scientific attainments, that the following letter which he recently addressed to one of the workers in zoölogy in this university, is here printed as an excellent illustration of the qualities which were characteristic of the departed naturalist.

The letter was written in reply to a description, sent Mr. Darwin, of a mollusk which closely resembled in color and form the sea-weed upon which it habitually lives. This sea-weed is the well known *Sargassum*, or Gulf-weed, which is found floating at the surface of the sea, sometimes in immense quantity. It has long, narrow, leaflike fronds of a peculiar form, with serrated margins, and is of an olive or reddish brown color, with darker blotches and spots.

The mollusk, which is somewhat like a common garden slug, is provided with three pairs of appendages which exactly resemble in form and color the fronds of the *Sargassum*. The body is also colored like the sea-weed and the whole animal is so similar in appearance to the plant on which it lives as almost to defy detection.

This resemblance is an instance of what is called "protective mimickry," many cases of which have been noted in other groups of animals. The mimickry is "protective" because the organism which "mimicks" the other is concealed from view, and thus protected from the attacks of enemies. Thus in the present case the mollusk is not distinguished from the plant by fish or other predatory animals, is therefore passed by, and escapes destruction. Some idea of the perfection of the resemblance may be gained from the fact that the mollusks escaped discovery for several hours during which the *Sargassum* was kept in a large, clear glass jar in the laboratory and examined several times in the presence of other animals.

The phenomena of mimickry are of interest on account of their clear illustration of the action of natural selection. Obviously there must be a tendency toward the survival of those individuals which are most effectually hidden—that is, those which most nearly resemble the objects with which they are constantly associated—while other individuals will tend to be weeded out. From this tendency has very commonly resulted general resemblances between organisms and their environments, such as the prevailing white color of arctic animals or the tawny colors of desert animals; and now and then have arisen resemblances so special and detailed as to merit the name of mimickry.

DOWN, BECKENHAM, KENT, *Dec.* 21, 1881.

Dear Sir:—I thank you much for having taken so much trouble in describing fully your interesting and curious case of mimickry. I am in the habit of looking through many scientific journals, and though my memory is now not nearly so good as it was, I feel pretty sure that no such case as yours has been described amongst the nudibranch molluscs.

You perhaps know the case of a fish allied to Hippocampus (described some years ago by Dr. Günther in Proc. Zoölog. Soc.) which clings by its tail to sea-weeds, and is covered with waving filaments so as itself to look like a piece of the same sea-weed. The parallelism between your and Dr. Günther's case makes both of them the more interesting, considering how far a fish and mollusc stand apart. It would be difficult for anyone to explain such cases by the direct action of the environment.

I am glad that you intend to make further observations on this mollusc, and I hope that you will give a figure, and if possible a colored figure.

With all good wishes from an old brother naturalist, I remain, dear sir,

Yours faithfully,
(Signed,) CHARLES DARWIN.

To E. B. WILSON.

A brief account of Mr. Darwin's work, from the pen of Mr. Wilson, may be found in the *American Literary Churchman*, Baltimore, May, 1882.

PUBLIC LECTURES.

Among the arrangements for public lectures in the Johns Hopkins University for the coming year are the following:—

Professor **James A. Harrison**, of Washington and Lee University, will deliver a course on *Anglo Saxon Poetry*. He is well known as the author of several volumes: "A Group of Poets," "Spain," etc.

William H. Carpenter, Ph. D., will give a course of lectures on *the Eddas*. His schedule includes the following topics: Old Norse literature; Iceland; the ancient literature of the Scandinavian North; the elder Edda; the younger Edda; other poetical literature; the Sagas; Old Norse historical literature; other prose literature.

Richard T. Ely, Ph. D., will give a course on *French and German Socialism.*

AMERICAN CHEMICAL JOURNAL.

At a general meeting of the German Chemical Society, December 17, 1881, Dr. A. W. Hofmann, Vice-President of the Society, spoke of the falling off in the number of original communications to the Society, as follows:

"On the other hand, the Society notes a falling off in original communications in comparison with former years, as the following figures show:—

	1878	1879	1880	1881
Communications............	602	604	563	518

This loss may mainly be referred to two causes. In the first place, a new chemical periodical, *The American Chemical Journal*, has been founded in America, which offers to chemists on that side of the Atlantic a prompt and convenient medium of publication; and thus many papers which formerly were sent directly to the *Berichte*, now reach it only at second hand. Of late, chemical research in America has increased to a very gratifying extent; and we may state with confidence that from twenty to thirty original papers have been lost to the Society from the cause above indicated."

MARYE MINERALOGICAL COLLECTION.

"This University is much indebted to Mr. George T. Marye, Jr., of San Francisco, for the effective interest which he is taking in its welfare and means of usefulness. Mr. Marye has declared his intention to provide the University with the most complete and representative collection, which can be obtained, of the mineral resources of the whole Pacific Coast. He is now very actively engaged in carrying out this purpose, and has already forwarded a large number of fine specimens, collected from Alaska, Oregon, Idaho, Wyoming, California, Nevada, New Mexico, Arizona, and Mexico. These represent, for the most part, the occurrence and associations of gold, silver, mercury, copper, and native sulphur."—*Extract from a report of Dr. H. N. Morse on the Courses in Mineralogy.*

ANNOUNCEMENT AS TO ADDITIONAL MINOR COURSE.

The additional minor course to be hereafter required of all undergraduate students (see page 35 of University Register, 1881–'82) may be made up as follows:

1. *Ethics and Psychology.* Lectures and class exercises. One hour a week through the year.
2. *History.* Introductory course, embracing lectures on Oriental History and exercises in Classical and early European History. Two hours a week through the year.
3. *English.* Course in modern English Prose, including exercises in grammar and style, lectures on the art of expression, and outlines of the History of English Literature. Two hours a week through the year, (see English courses, 8 and 9, University Circular No. 16, p. 230).

Total, five hours weekly.

PROFESSOR CAYLEY.

The annexed extract from Pliny, Epist. i. 22, has been pointed out by Professor Morris as affording a striking parallel to the remarks made by one of the speakers on the occasion of the public reception given to Professor Cayley, at the Johns Hopkins University, in the month of February last. They occur in a letter addressed by Pliny to his friend, Catilius Severus, lamenting the illness of Titius Aristo, who (like our eminent guest) was a distinguished jurist, whose name frequently occurs in the Digest.

It may not be generally known that some of Prof. Cayley's conveyancing drafts have been accepted as models by the legal profession, and will be found printed as such in *Davison's Precedents.*

Referring to Titius Aristo, Pliny writes, *Nihil est quod discere velis, quod ille docere non possit: mihi certe, quotiens aliquid abditum quaero, ille thesaurus est.*

OPENING OF THE NEXT ACADEMIC YEAR.

The next academic year will begin on Tuesday, September 19th, 1882. The first week is devoted to the examination of candidates for admission and matriculation, and to the organization of classes.

The examinations for matriculation will take place as follows:

Wednesday, September 20.		*Friday, September 22.*	
ALGEBRA, - - - - -	9—12.	LATIN, - - - - -	9—12.
GEOMETRY, - - - -	3—6.	GREEK, - - - - -	3—6.
Thursday, September 21.		*Saturday, September 23.*	
TRIGONOMETRY, - - -	9—12.	GERMAN, - - - - -	9—12.
ANALYTIC GEOMETRY, - -	3—6.	FRENCH, - - - - -	3—6.

The results of the matriculation examinations will be made known September 26th, at 12 M.

Instructions will be resumed Tuesday, September 26th, 1882.

RECENT APPOINTMENTS, ETC.

Mr. H. C. G. **Brandt**, Associate in German, who has been connected with the Johns Hopkins University since its opening in 1876, has accepted an invitation to become Professor of German in Hamilton College, New York.

E. B. **Wilson**, Ph. D., 1881, an Assistant in the department of Biology, and one of the most able and persistent workers in the Chesapeake Zoölogical Laboratory, is about to spend a year in Europe for the further prosecution of his scientific work.

William A. Noyes, Ph. D., 1882, has accepted the position of Assistant Professor of Chemistry in the University of Minnesota.

Charles John Bell, A. B., Harvard, recently appointed a Fellow in this University, has resigned in order to accept the chair of Chemistry in the Pennsylvania State College.

William C. Thayer, A. B., Columbia, recently the holder of a graduate scholarship, has accepted the position of Professor of Mathematics in Hobart College, New York.

Oscar H. Mitchell, A. B., Marietta, and Ph. D., Johns Hopkins, 1882, recently a Fellow, has accepted the post of Professor of Mathematics in Marietta College, Ohio.

University Circular, No. 16, containing full announcements of the courses offered for the next academic year, will be sent on application.

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